NEYVELI LIGNITE POWER STATION
ENVIRONMENTAL IMPACT ASSESSMENT

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NEYVELI LIGNITE POWER STATION

ENVIRONMENTAL IMPACT ASSESSMENT

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EXECUTIVE SUMMARY

The Project Outline

The project is one of the first to have been proposed under the Government of India initiative to widen the scope for private sector participation in the development of the Indian electricity supply industry and comprises a 250 MW capacity power station.

The plant will be constructed at Neyveli, Tamil Nadu, in close proximity to the existing Mines I and II which currently supply the Neyveli Lignite Corporation (NLC) Thermal Power Station (TPS) I and II.

The site for the proposed new power station is 12 km from the Neyveli township, to the west of NLC TPS II and to the north of the railway line to Vriddhachalam. Road and rail access to the site exists. The nearest railway station, Umangalam, is at a distance of 5 km and the main road connection Cuddalore and Vriddhachalam is 4 km from the site.

The proposed plant for this project will comprise a single unit have a capacity of 250 MW, fired on local lignite fuel. The plant will comprise a single boiler/turbine generator unit together with station auxiliary systems. In addition to these the plant will include necessary infrastructure developments including water supply, fuel supply, power export/import, ash and liquid disposal systems.

NLC will supply up to 1.5 million tonnes of lignite per year from Mine II and to supply additional quantities, from Mine I. The entire power output of this unit is expected to be taken by Tamil Nadu Electricity Board by connecting the unit to the existing 230 kV transmission lines from Neyveli TPS to both the Perambalur and Attur substations.

Existing Environment

The proposed site is situated 12 km west of Neyveli town and 4 km north of the main Cuddalore-Vriddhachalam road. The vegetation in the region is coarse and the area contains no prime agricultural land. It is also characterised by a lack of national monuments, wildlife sanctuaries and ecologically sensitive site.

Industrial facilities within a 10 km radius of the site include TPS I, TPS II, a lignite fertiliser plant, a briquetting plant, and lignite mines I and II.

The background ambient air quality is below the Indian and World Bank limits. Existing noise values within 2 km radius of the site were all below 50 dB(A). There are no houses on the site and therefore, resettlement issues would not arise. Borehole analyses have indicated that there is sufficient groundwater available as make-up water to the cooling towers and feed to the desalination plant for this power station.

Construction Phase Impacts and Mitigatory Measures

Environmental effects of the construction phase are expected to be temporary. Construction will have potential impact upon air quality, primarily related to dust and grit, with lesser problems arising from sulphur dioxide, carbon monoxide, oxides of nitrogen and hydrocarbons resulting from vehicle pollution. In addition, increased traffic in the area during the construction phase may cause some disturbance and displacement of local flora and fauna but this is limited to the immediate environs of the construction site. Noise is not considered to be a problem because of the location of the nearest residential area. Positive effects during construction include potential employment for local people and an injection of capital into the local economy.

Operational Phase Impacts and Mitigatory Measures

Ecology

The impacts of air quality, water quality, noise and solid waste disposal during the operational phase will have insignificant impact on the local ecology. On the existing site, there are no rare species of flora or fauna or plants of special economic and medicinal value.

Socio-Economic Environment

Neyveli's large residential area is closely associated with the mining industry, power generation, the fertiliser plant and general service industries.

Besides being the main employer, NLC is also responsible for providing the bulk of the other services. These include houses, schooling and security. Neyveli Lignite Corporation also provides a political base and a state political representation, as well as providing water and power.

The land use of the area is dominated by mining activity although other land use types include agriculture, residential areas, industrial interests and natural or semi natural vegetation.

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Air Quality

Existing background levels for SO_2, NO_2 and particulates were found to be below the Indian and World Bank ambient air quality limits.

Dispersion modelling has indicated that the contribution from the proposed development to the ambient air quality will be insignificant and the projected ambient air quality values will be well below the Indian and World Bank Standards. The Indian 8 hour standards may be approached for Pasquill Stability A conditions but this stability category occurs on very rare occasions.

Water Management

Water will be abstracted from the ground as feed to the desalination plant and make-up water to the cooling towers. Borehole analysis has shown that the water table will not be disturbed and that seawater penetration would not be experienced.

Solid Waste Management

The disposal of ash would to be considered in detail throughout the plant life to explore and exploit new emerging disposal and utilisation techniques . Ash disposal area has been reserved adjacent to the proposed development but every effort will be made to reduce the quantity of ash requiring disposal through exploring utilisation options such as brick making, construction of ash blocks, road base, concrete aggregate, filler and back-fill of the mines.

Environmental Management Plan

The main aim of the environmental management plan is to ensure that the proposed Neyveli Power Station is operated with minimum environmental impact. Therefore, systems will be installed to ensure that the feedstocks such as fuel and water are properly controlled and that all releases to the environment are determined and comply with the relevant standards and guidelines.

In addition to determining releases to the environment, other aspects considered include work plans and schedules, implementation and resources, emergency procedures and training of personnel.

Environmental Monitoring

Monitoring of certain parameters during both the construction and operational phases of the power station should include checks on fuel quality, stack emissions, water effluents, noise and ash pond overflow.

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Conclusion

Overall, the potential impacts on the environment are considered to be insignificant following appropriate mitigation measures being incorporated into the project at the design stage. Expected emission levels from the plant and their impacts on air quality are within the standards specified by the regulating authorities. A stack of 220 m high will be provided to comply with the Indian standards. The positive impacts of the project far outweigh the negative ones and therefore, we consider that the proposed power station should proceed.

SECTION 1

INTRODUCTION

SECTION 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 General

There are extensive proven lignite reserves in the Neyveli area of south eastern India which are presently estimated at around 33000 million tonnes. This is sufficient to sustain over 5000 MW power projection for more than 80 years.

The Neyveli Lignite Corporation (NLC) began developing lignite mines and associated mine-mouth thermal power station approximately thirty years ago in order to utilise these vast fuel resources for power generation. The location of Neyveli in relation to Madras is shown Figure 1.1.

NLC established their first 600 MW thermal power station (TPSI) and lignite mine (Mine I) in the 1960s. Development of the second 1470 MW thermal power station (TPS II), again with its own captive mine (Mine II), was commenced in 1978 following growth in power demand in the southern region. A third power station and mine are tentatively planned for the future.

NLC commissioned a feasibility study in 1987 for a further unit of 210 MW to be added to TPS II. This unit was named Zero unit on account of its proposed position adjacent to unit one. This study established that the production capacity of Mine II was sufficient to meet the needs of the existing TPS II units and to provide sufficient lignite for a further 210 MW nominal unit. This project, however, was never implemented by NLC.

In order to achieve accelerated growth through speedier implementation of power development programmes. steps have been taken to restructure and re-organise the Indian power supply industry. The Government of India initiative to widen the scope for private sector participation in the development of the Indian Electricity Supply Industry was introduced in 1992 under legislation that amended the Electricity (Supply) Act 1948. This initiative sought to mobilise private sector resources to bridge deficit between the planned public sector development of the electricity supply system over the period 1992-1997 and the total development required to match forecast demand.

The Government of India working group identified a possible shortfall in capacity of 5645 MW and it is intended that private sector development should address this shortfall.

A Memorandum of Understanding was signed by ST Power Systems Inc. (STPS) and NLC on 31st August 1992 which grants STPS the exclusive right to build, own and operate a single unit power plant at Neyveli.

The Memorandum of Understanding also grants STPS first refusal on any option given for the private sector to install additional capacity at Neyveli. However, it does not give any guarantee that additional capacity options will be offered to the private sector. In the first phase, only one unit of 250 MW is to be installed, but ultimate capacity is envisaged as 3 x 250 MW.

The power from the proposed project will be transmitted by Tamil Nadu Electricity Board (TNEB) via their 230 kV lines from Neyveli TPS II which will be looped in and out of the new power plant substation.

1.1.2 Project Outline

The project is one of the first to have been proposed under the Government of India initiative to widen the scope for private sector participation in the development of the Indian Electricity Supply Industry and comprises the first phase of a potential three unit lignite fired power station of 750 MW nominal capacity.

The plant will be constructed at Neyveli, Tamil Nadu, in close proximity to the existing NLC lignite Mines I and II which currently supply the NLC TPS I and II power plants.

The site for the proposed new power station, as shown in Figure 1.2, is 12 km for Neyveli township, to the west of NLC TPS II power plant and to the north of the railway line to Vriddhachalam. Road and rail access to the site exists. The nearest railway station, Umangalam, is at 5 km distance and the main road connecting Cuddalore and Vriddhachalam is 4 km from the site.

The proposed plant for this project is a single unit having a maximum continuous rating (MCR) of 250 MW. The plant will comprise a single boiler/turbine generator unit together with unit and station auxiliary systems. In addition to these, the plant will include necessary infrastructure developments, including water supply, fuel supply, power export/import, ash and liquid disposal systems.

As there is potential to install two further units of similar capacity, the infrastructure and common facilities will be designed to be extendible for an ultimate three x 250 MW unit station. However, an important consideration is installation of only the plant essential for the first unit and minimum expenditure at this stage for the provision of facilities associated with the second or the third units.

NLC have committed to guarantee a supply of up to 1.5 million tonnes of lignite per year from Mine II (broadly adequate for this phase of the project) and to supply additional quantities, subject to availability, if required. The entire power output of this first unit is expected to be taken by TNEB by connecting the unit to the existing 230 kV transmission lines from Neyveli TPS II to both the Perambalur and Attur substations.

1.2 ENVIRONMENTAL LEGISLATION

1.2.1 Requirement for an Environmental Impact Assessment

1.2.1.1 Relevant Indian Requirements

Activities associated with air, water and land pollution are stipulated in the following acts, regulations and by-laws:

I The Water (Prevention and Control of Pollution) Act 1974 (Act No. 6 of 1974).

The Water (Prevention and Control of Pollution) Amendment Act 1978 (Act No. 44 of 1978).

The Tamil Nadu Water (Prevention and Control of Pollution) Rules, 1983.

II The Water (Prevention and Control of Pollution) Cess Act, 1977 (Act No. 36 of 1977).

The Water (Prevention and Control of Pollution) Cess Rules, 1978.

III The Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981).

The Air (Prevention and Control of Pollution) Amendment Act, 1987 (Act No. 47 of 1987).

The Tamil Nadu Air (Prevention and Control of Pollution) Rules, 1983.

IV The Environmental (Protection) Act, 1986 (Act No. 29 of 1986).

The Environmental (Protection) Rules, 1986

The Environmental (Protection) Amendment Rules, 1987

The Environmental (Protection) Second Amendment Rules, 1987

The Environmental (Protection) Third Amendment Rules, 1987

The Environmental (Protection) Fourth Amendment Rules, 1987

V The Hazardous Wastes (Management and Handling) Rules, 1987.

Under the Environmental (Protection) Act, 19986, large scale development in the power sector requires that an Environmental Impact Assessment (EIA) be undertaken in order that the natural environment do not deteriorate significantly and to illustrate that the project is necessary for sustainable development.

1.2.1.2 World Bank Requirements

The project will partly be funded by the International Finance Corporation (IFC), who will incorporate the World Bank's requirements for environmental protection. It is a general policy of the World Bank that projects of this type proposed would required an environmental impact assessment (World Bank Operational Directive: 4.01).

For the proposed development, the requirement for an EIA and the format of the EIA Report has been based on IFCs Terms of Reference, which have been reproduced in Appendix A. We have slightly modified the proposed format of the EIA Report to take into consideration the Indian requirements; however, all the required issued are taken into consideration.

1.2.2 Environmental Standards

1.2.2.1 General

The project will have to meet standards covering atmospheric emissions and air quality, aqueous effluents, noise, solid waste disposal and those associated with health and safety.

1.2.2.2 Indian Environmental Standards

In India, thermal power stations have been categorised as highly polluting industries. The following standards for emission and control are required to be complied with:

(a) Standards for particulate matter emissions as per Emission Regulations July, 1984 and Environment Protection Rules 1986, Rule 3 Sch. I as corrected by 508(E) dated 3.01.89 and S 'O' 190(E) dated 15.03/89:

Boiler Size	Protected Area	Other Area	
		Old Plants before 1979	New Plants after 1979
Less than 200/210 MW	150 mg/Nm^3	600 mg/Nm^3	350 mg/Nm^3
200/210 MW and above	150 mg/Nm^3		150 mg/Nm^3

The ambient air quality standard for particulates is 500 $\mu g/m^3$ in India for industrial areas, 200 $\mu g/m^3$ for residential and rural areas and 100 $\mu g/m^3$ for sensitive regions.

(b) Standards for Sulphur Dioxide Control as per Environment Protection Rule 1986 Rule 3 Sch I and Indian Emission Regulation July 1984 (through stack height):

Boiler Sizes	Stack Height
1. Less than 200 MW	H = 14 (Q) 0.3 meters
2. 200 MW and less than 500 MW	220 meters
3. 500 MW and above	275 meters

where

H = Stack height in meters
Q = Sulphur Dioxide emission in kg/h

The ambient air quality guidelines are currently under review but for the purpose of this assessment, the values given below will be consulted.

The maximum permissible concentration in micrograms/m^3 of air at ground level (8 hours sample) must comply with the following:

Category	**SO_2**
Industrial area and mixed use	120 micrograms/m^3
Residential and rural areas	80 micrograms/m^3
Sensitive areas	30 micrograms/m^3

(c) Standards for NO_x emission

There is no existing standards so far for NO_x emissions from thermal power stations. However, the air quality guidelines are as those for sulphur dioxide given above.

(d) Standards for thermal pollution of water

For open cooling water cycle the standard prescribes that the difference between the temperature at the intake and the temperature at the outflow to the lake or river should not be more than 5°C. However, for closed CW system (water cooling towers) there is no restriction.

(e) Standards for effluents discharge

All the effluents must be neutralised and treated before discharge into waterways or drains.

(f) Noise pollution standards

Currently there are no noise standards or noise pollution caused by thermal power plants. World Bank values will be used during the assessment stage.

1.2.2.3 World Bank Environment Guidelines

(a) Atmospheric Emissions

Atmospheric pollutants of regional concern, caused by the operation of the existing and new units, are particulates, sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) but expressed as nitrogen dioxide (NO_2).

Control of particulates within the World Bank guideline values of 100 to 150 mg/m^3 will be achieved by means of the use of particulate control measures.

The World Bank emission standard for NO_X of 260 nanograms per Joule of heat input and this NO_X standard, expressed as NO_2 concentrations, applies to lignite fuel fired in a thermal power plant. The World Bank ambient air quality guidelines value for NO_2 is 100 $\mu g/m^3$.

Emission standards for sulphur dioxide are also based on the World Bank guidelines (Ref. 1) in connection with both controlling emissions at source and maintaining the air quality in the Neyveli area.

The following standards have been considered in the assessment:

(a) The need to meet World Bank Guidelines for emissions and ground level concentrations contained in the Guideline on sulphur dioxide emission standards. These guidelines are summarised in Table 1.1.

(b) The need to meet World Bank Guidelines on ambient air quality for long term exposure (annual guideline value). These guidelines are shown in Table 1.2.

(b) Aqueous Discharge Standards

The World Bank guidelines in connection with aqueous discharges are summarised in Table 1.3.

(c) Environmental Guidelines on Noise

The World Bank has issued a set of broad environmental guidelines (Ref 1) which includes guidance on assessing the potential occupational and environmental impacts of noise sources and the broad measures available for mitigation. The quantitative criteria for environmental assessment are based o US Environmental Protection Agency valuation.

Of relevance to the Neyveli power station proposed are the following guide values:

Residential areas	Ldn 55 dB(A)
Industrial areas	Leq (24 hr) 70 dB(A)
Recreational areas	Leq (24 hr) 70 dB(A)
Farmland	Leq (24 hr) 70 dB(A)

(d) Control of Solid Waste

Currently there are no World Bank guidelines with respect to the disposal of power station wastes. However, in our assessment, we would be ensuring that all solid wastes are disposed of by suitable means so as to minimise the risk to the local environment.

(e) Preservation of Cultural Properties

The World Bank has adopted a general policy to help preserve cultural property and avoid its elimination (Ref 2).

When potential projects are being identified, pertinent authorities and experts are consulted to assess the cultural property elements of the proposed project site. If cultural property is present, relevant government authorities and other experts are called upon to help design mitigatory measures.

"Cultural property" (a United Nations' term) denotes sites or artifacts of archaeological (prehistoric), palentological, historic, religious, and unique natural value; it encompasses remains left by previous human inhabitants as well as unique natural environmental features.

The procedural guidelines for the survey, salvage, excavation or preservation of an archaeological site or culturally significant area as listed are:

- sites should not be destroyed until a professional survey has been undertaken, even if it is thought that nothing of cultural significance is present;
- all cultural sites and artifacts must be treated as a finite resource that can never be replaced;
- all cultural discoveries must be reported to the authorities;
- professional assistance is required when digging, rehabilitating or preserving cultural property.

(f) Occupational Health and Safety (World Bank Guidelines)

As part of this environmental assessment occupational health and safety issues have been recognised as important for the construction of the power station.

The World Bank guidelines (Ref 3) will be taken into consideration at the design stage by the Contractor.

The main health and safety issues in a coal or oil fired power station are as follows:

- injuries from hazards (burns and falls)
- lung diseases
- skin diseases (exposure to fuel oil residues)
- hearing disorders (exposure to excessive plant noise)
- heat stress (exposure to heat and humidity).

The World Bank guidelines describe a series of measures that should be taken to minimise the risk of occurrence of the above health and safety disorders. The guidelines are divided into the following categories:

- safety
- electrocution
- health
- temperature and humidity
- noise
- dermatitis
- toxic gases
- dust
- working in confined spaces
- medical examination
- training
- record keeping.

The guidelines under each of these headings are summarised in Appendix B.

1.3 LICENCES AND CONSENTS

To set up a project in the Electricity Sector, a number of statutory and non-statutory clearances are required. In particular, project clearance is required from the Central Electricity Authority (CEA) for which the feasibility report has already been submitted.

Environmental Clearance is required from the Ministry of Environment and Forests (MEF) which will require submission of an EIA. Clearance will also be required from the Civil Aviation Authority for high chimney construction and application for this has been initiated.

.Clearance is required from the Ground Water Board for abstraction of water supplies; however surveys have been carried out by the authorities for this site and it is unlikely that fresh clearance will be required.

1.4 THE EXTENT AND PREPARATION OF AN EIA STUDY

1.4.1 Study Area

This report addresses the environmental and socio-economic aspects of the construction and operation of the Neyveli 250 MW lignite fired power station plant.

For the atmospheric air quality modelling, a study area of 15 km radius around the site has been considered. Outside this area, the project is anticipated to have minimal impact on the environment.

Impacts on noise are limited to the site itself and the nearest residences, as are impacts on visual amenity.

Examination of traffic impacts is mainly confined to the site and the nearby Neyveli township. This is mainly because the majority of the plant's employees are expected to live locally.

1.4.2 Acknowledgement

This Environmental Impact Assessment has been prepared by Ewbank Preece Limited (EPL), Brighton, United Kingdom, acting on behalf of ST Power Systems Inc., Maryland and the International Finance Corporation, Washington D.C. EPL were assisted with technical and engineering aspects by Premier Energy Technologies Private Ltd and Tata Energy Research Institute, New Delhi.

Visits were made by EPL staff to India on a number of occasions in 1993 to hold meetings, visit the site, collect baseline data and arrange for further data acquisition where baseline data was unavailable or inadequate.

During the visits, discussions were held with:

- Neyveli Lignite Corporation, Neyveli
- Central Electricity Authority, New Delhi
- Ministry of Environment & Forests, New Delhi
- Tamil Nadu Pollution Control Board, Madras

We gratefully acknowledge the help, advice and information provided by all these organisations.

1.5 REPORT STRUCTURE

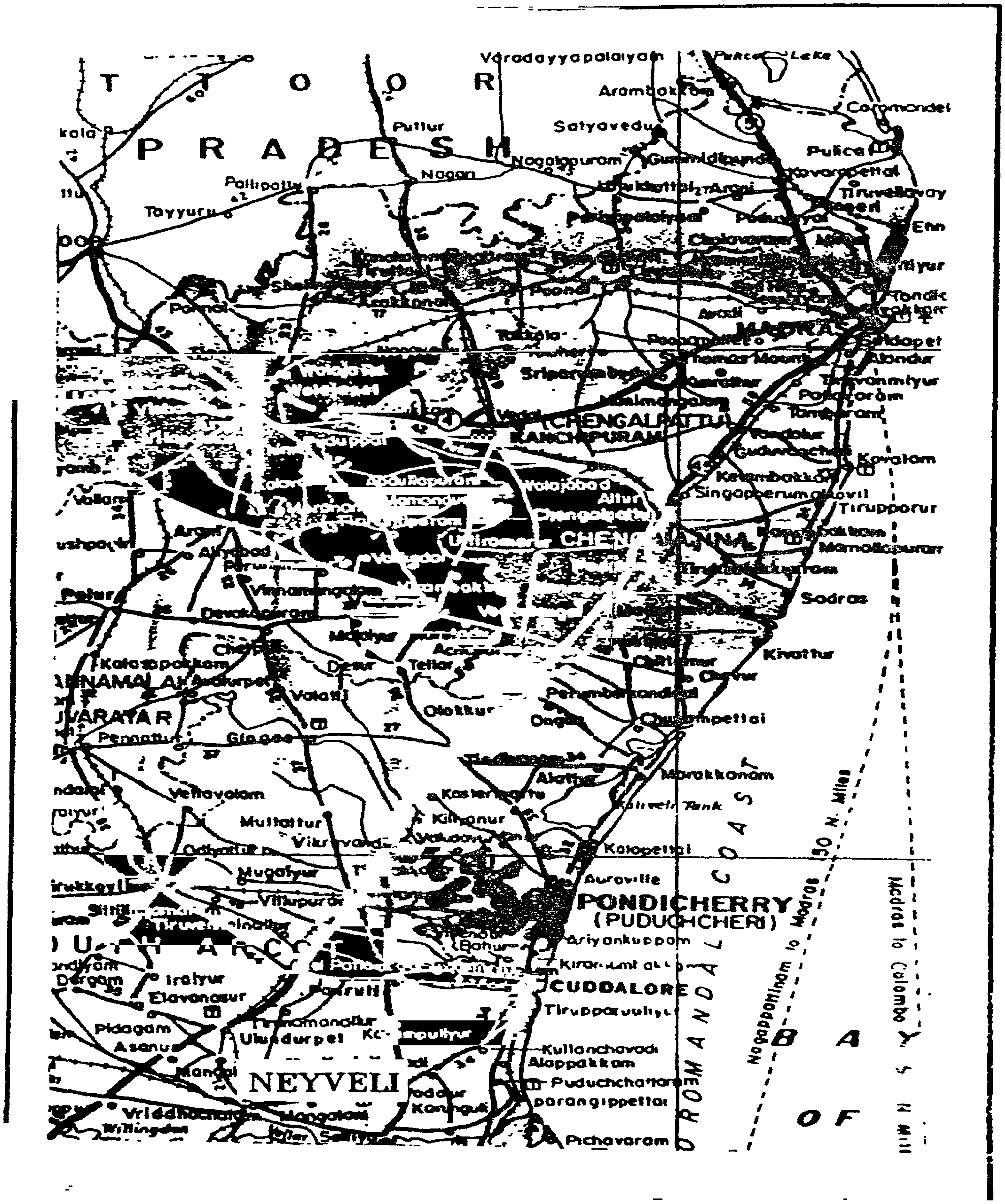
The report structure has been based upon recommendations provided by both ST Power Systems Inc and the International Finance Corporation.

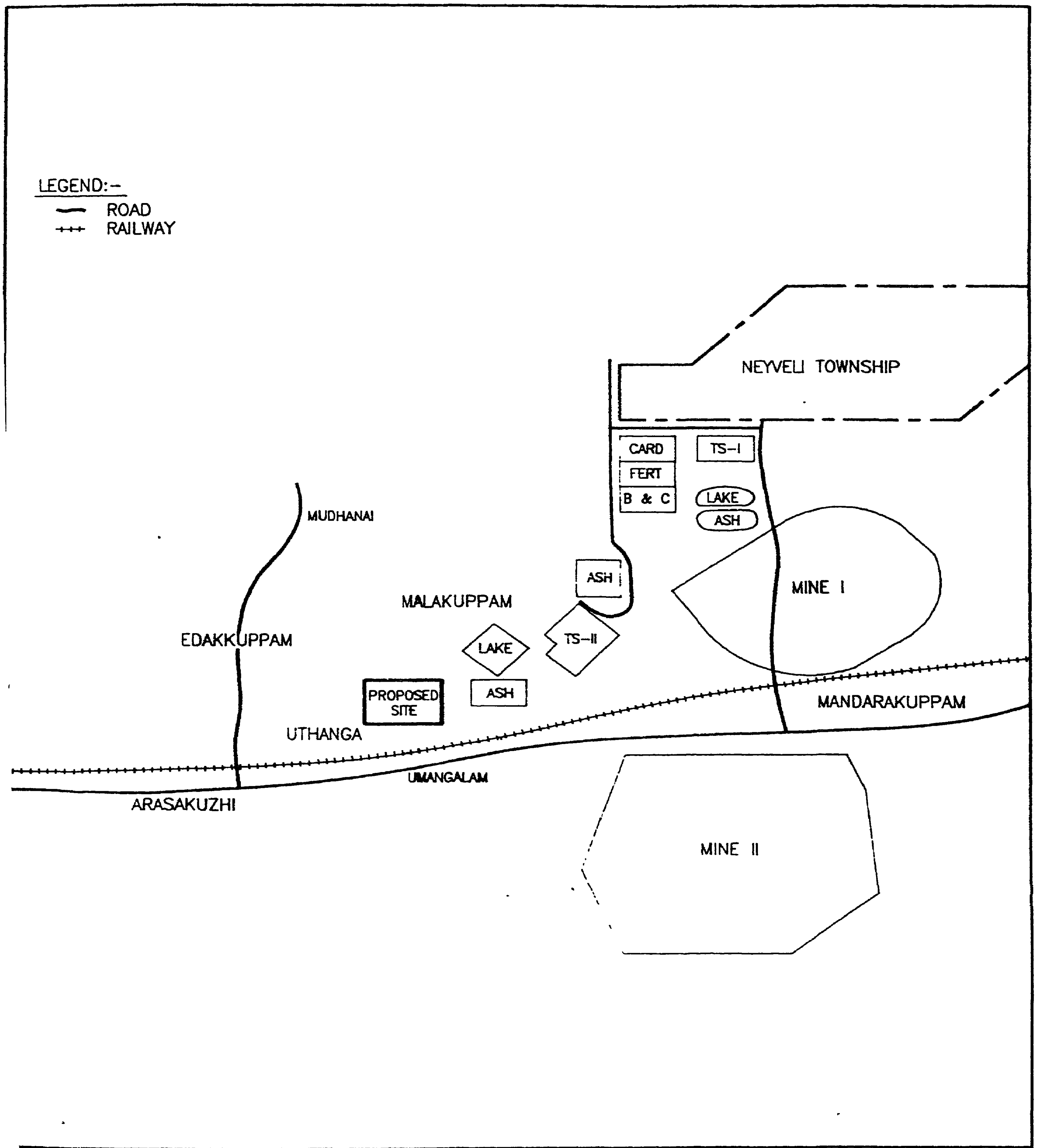
Section 2 describes in detail the requirement for new plant and justifies the selection of the proposed option.

Section 3 covers the technical aspects of the proposed development. Section 4 focuses on the existing physical environment and considers factors such as hydrology, climate, soil, air quality and present noise levels. Section 5 considers the ecological environment including recorded flora and fauna. Section 6 covers the existing social and economical environment of Neyveli and surrounding areas.

Section 7 describes environmental impacts and mitigation measures associated with construction whilst Section 8 considers impacts arising from operation and mitigation measures for limitations of these. Section 9 outlines a suitable environmental management plan whilst Section 10 considers the monitoring plan necessary to measure its success. Finally, conclusions of the EIA are given in Section 11.

POSITION OF NEYVELI





LOCATION OF PROPOSED SITE

EWBANK PREECE

FIG. 1.2

Table 1.1

WORLD BANK SULPHUR DIOXIDE EMISSIONS GUIDELINES

Background Air Quality (SO_2 Basis)			**Criterion I Max. SO_2 Emission (t/day)**	**Criterion II Max. allowable ground level increment to ambient (ug/m^3 one year average)**
	Annual Average	**Max. 24−hour Interval**		
Unpolluted	<50	<200	500	50
Moderately polluted *				
low	50	200	500	50
high	100	400	100	10
Very polluted **	>100	>400	100	10

* For intermediate values between 50 and 100ug/m^3 linear interpolations should be used

** No projects with sulphur dioxide emissions recommended in these areas

Table 1.2

World Bank Guide Values on Ambient Air Quality Values

Parameter	Reference Period	Recommended Ground Level Concentration Guide Values
Sulphur Dioxide	Long Term Exposure (Annual arimethic mean conc.)	100 ug/m^3
	Short Term Exposure (24hr maximum peak)	500 ug/m^3
Nitrogen dioxide	Long Term Exposure (Annual arimethic mean conc.)	100 ug/m^3
Particulates	Long Term Exposure (Annual geometric mean)	100 ug/m^3
	24hr mean peak	500 ug/m^3

Table 1.3

World Bank Guidelines on Liquid Effluents

Parameter	Guideline
pH	6 – 9
Biological Oxygen Demand	50 mg/l
Total Suspended Solids	60 mg/l
Oil and Grease	10 mg/l
Total Heavy Metals	5 mg/l
Temperature	Maximum of 5°C above ambient (3°C above if receiving waters are more than 28°C)

SECTION 2

PROJECT JUSTIFICATION

SECTION 2

PROJECT JUSTIFICATION

2.1 DEMAND FOR ELECTRICITY

The demand for power in the southern grid has continued to grow at a rapid rate as industrial development outstrips the availability of electricity. This has resulted in power shortages, imposing supply restrictions on both demand and energy requirements. The annual average rate of growth in electricity consumption in the nine year period from 1980 to 1989/90 was 9.16% even though power shortages still persist.

Table 2.1 indicates projections of peak demands and energy requirements on an All India basis at the end of various five year plans as given in the 14th Electric Power Survey of India report.

On the basis of the above report a working group in 1989 recommended additional generating capacity for India totalling over 38 000 MW (based on Scenario A). Taking into account changes that have occurred since then, another scenario (Scenario C) has been developed which demonstrates that by 1994-95 there will be a shortfall of some 768 MW generating capacity in Tamil Nadu and available energy will be some 1129 GWh below the anticipated requirement, as shown in Tables 2.2(A), 2.2(B) and 2.2(C).

Deficits in installed capacity and energy supply capability have forced both Tamil Nadu Electricity Board (TNEB) and other utilities to impose restrictions on supply for a number of years. Over the period 1985-91, power cuts of approximately 20% have been necessary in Tamil Nadu, with associated energy cuts of approximately 40%.

There is clearly an immediate need for additional generating capacity in Tamil Nadu, capable of operating at high load factors, based on the levels of existing energy cuts. The proposed development at Neyveli is essential for sustainable development in the agricultural, industrial and residential sector.

2.2 POWER GENERATION OPTIONS

The power generation mix in Tamil Nadu and Southern Grid as given by Scenario C projections would be for the period up to 1997:

	Tamil Nadu	**Southern Grid**
Thermal and Gas	56.6%	57.8%
Hydro	35%	40%
Nuclear	8.4%	2.2%
Total	**100%**	**100%**

Hydro electric resources in the South are now very limited and thermal or nuclear power stations would appear to be the only logical options available.

Accidents that have occurred at places such as Three Mile Island (USA) and Chernobyl (Ukraine formerly USSR) have raised serious doubts about the safety aspects of nuclear power generation. The implications of failures with the potential for dispersal of long lived radionuclides across continents have resulted in heavy cost penalties as additional safety features are included in the designs. Easing of tensions between East and West, agreements on arms limitation and a slowdown in the development of fast breeder reactors has reduced the demand for by-products produced from the reprocessing of nuclear fuel, reducing revenue and increasing costs.

Other problems associated with nuclear plants include relatively high costs, long lead times (typically 5-6 years) and significant uncertainty associated with public acceptability. The typical sizes of the nuclear plants would be well in excess of the planned 250 MW at Neyveli.

Thermal power stations of conventional design based on lignite represent the most economic choice, particularly where it is known that significant fuel reserves are available. Coal would need to be transported over 1000 km from Bihar or Orrisa whilst oil and gas would need to be imported.

2.3 SITE SELECTION

There are extensive lignite reserves in the Neyveli area which are presently estimated at around 3.3 billion tonnes (3.3×10^9). The Neyveli Lignite Corporation (NLC) has been developing lignite mines and associated thermal power stations for the past 30 years resulting in two power stations at present totalling 2070 MW. Consequently, there are existing 230 kV transmission lines from the site to substations at Attur and Perambalur which can be used.

Factors considered for site selection are as follows:

i) Site is at the mouth of lignite mines.

ii) NLC is ready to give lignite from their mine stock from where it can be transported by conveyor or road.

iii) Station make-up water for CW system and other requirements would be available by pumping ground water.

iv) Land has already been acquired for the power plant by NLC which would be obtained on lease/transfer.

v) Absence of any rehabilitation problems.

vi) The power station is proposed in the same areas as the other power stations of NLC and all environmental aspects can be taken care of easily.

vii) Power evacuation lines can be taken from outdoor switchyard of this station easily by Tamil Nadu Electricity Board (TNEB).

TNEB wants to re-route their nearby existing 230 kV lines through the outdoor switchyard of this station to carry and evacuate the power of this station.

viii) Infrastructure facilities already available at Neyveli can be availed.

ix) Approach to site by road and rail is available. Nearest railway station is 5 km.

x) The site is neither near a metropolitan city nor near any ecologically sensitive area, national park, wild life sanctuaries, lakes, etc.

xi) The site is far from falling in flood plain of the river system. It is 4 km from the main Viriddhachalam Cuddalore road.

xii) The site is far from coastal areas and there are no archaeological, historical, cultural, religious or tourist sites of any importance, or defence installations within 10 km radius.

Land is available and has already been acquired by NLC for the project, therefore it is anticipated that no additional land would be needed.

On the information available to us we consider that the proposed site will not present any major difficulties with respect to access, or construction.

2.4 CONSEQUENCES OF NON PROJECT IMPLEMENTATION

2.4.1 Introduction

During 1991/92, the Southern Grid faced a peak capacity deficit of 1090 MW and an energy deficit of 441 GWh even after allowance for imports from the regional power plant in the central sector. Of these deficits, a 392 MW peak capacity shortfall and an energy deficit of 46 GWh was incurred by Tamil Nadu State.

From the data given in paragraph 2.1, it can be seen that these deficits both in terms of installed capacity and energy are expected to increase significantly by 1995 and both the Southern Grid and Tamil Nadu State will continue to face peaking and energy deficits.

Beyond this period, the peak demand for power in the southern region of India is expected to increase to 15 986 MW by 1997 (the end of the eighth five year plan) with a forecast installed power generating capacity for the southern region of around 20 627 MW. The peak demand is expected to increase further to approximately 21 971 MW and 30 242 MW by the end of the nine (1997-2002) and the tenth (2002-2007) plans respectively.

The deficits in installed capacity and energy supply capability has forced both TNEB and other utilities to impose restrictions on supply for a number of years. Over the period 1985 to 1994, power cuts of approximately 20% have been necessary in Tamil Nadu with associated energy cuts of approximately 40%.

2.4.2 No-Project Option

Clearly there is an immediate need for additional generating capacity in Tamil Nadu and any such plant would be able to operate at high load factors, based on the levels of existing energy cuts. There is no option but to set up thermal power stations as soon as possible, as is clear from the above position discussed in preceding paragraphs.

2.4.3 Energy Conservation

It is clear from the 14th power survey and the reports of working group on power that power deficits in the State will continue to be very high and cannot be mitigated by energy conservation measures under the present circumstances, although energy conservation is always a desired objective.

2.5 CONCLUSION

From the above, it is therefore concluded that a lignite based power station at Neyveli is necessary for the welfare of the State.

Table 2.1

Projected Energy Demand for Different Regions of India

Region	8th Plan (1994–95)		9th Plan (1999–2000)		10th Plan (2004–05)		11th Plan (2009–10)	
	Energy Requirement (GWH)	Peak Demand (MW)	Energy Requirement (GWH)	Peak Demand (MW)	Energy Requirement (GWH)	Peak Demand (MW)	Energy Requirement (GWH)	Peak Demand (MW)
Northern Region	110 841	20 814	162 954	30 295	232 334	42 790	318 715	58 177
Western Region	105 779	17 109	148 522	23 992	202 762	32 713	264 017	42 552
Southern Region	90 664	15 986	125 372	21 971	173 621	30 242	240 647	41 665
Eastern Region	47 326	8 702	71 420	12 998	103 636	18 701	143 934	25 791
North Eastern Region	4 890	1 118	8 483	1 867	13 230	2 821	18 467	3 839
Andaman & Nicobar Islands	98	28	299	63	477	126	890	226
Lakshadweep	14	3	23	5	36	8	53	11
All India	359 612	63 760	517 005	91 191	726 096	127 401	986 777	172 262

Table 2.2

Relationship between Installed Capacity and Projected Deand

Table 2.2(a) ALL INDIA

	Scenario A	Scenario B	Scenario C
Installed capacity (MW)	103 098	90 478	86 597
Peak (MW)			
Load	63 760	63 760	63 760
Availability	58 847	53 152	50 841
Surplus/deficit	(−) 4 913	(−) 10 608	(−) 12 919
(percentage)	(−) 7.7%	(−) 16.6	(−) 20.3
Energy (GWH)			
Requirement	359 612	359 612	359 612
Availability	381 737	349 896	337 295
Surplus/deficit	(+) 22 125	(−) 9 716	(−) 22 317
(percentage)	(+) 6.2%	(−) 2.7%	(−) 6.2%

Table 2.2(b) SOUTHERN GRID

	Scenario A	Scenario B	Scenario C
Installed capacity (MW)	23 941	21 287	20 627
Peak (MW)			
Load	15 986	15 986	15 986
Availability	14 874	13 706	13 324
Surplus/deficit	(−) 1 112	(−) 2 280	(−) 2 662
(percentage)	(−) 7.0%	(−) 14.3 %	(−) 16.7%
Energy (GWH)			
Requirement	90 664	90 664	90 664
Availability	87 210	79 897	77 809
Surplus/deficit	(−) 3 454	(−) 10 767	(−) 12 855
(percentage)	(−) 3.8%	(−) 11.9%	(−) 14.2%

Table 2.2 continued

Relationship between Installed Capacity and Projected Demand

Table 2.2(c) TAMIL NADU

	Scenario A	Scenario B	Scenario C
Installed capacity (MW)	5 084	5066	5 066
Peak (MW)			
Load	4 745	4 745	4 745
Availability	4 264	4 034	3 977
Surplus/deficit	(−) 481	(−) 711	(−) 768
(percentage)	(−) 10.1%	(−) 15.0%	(−) 16.2%
Energy (GWH)			
Requirement	27 016	27 016	27 016
Availability	28 431	26 285	25 887
Surplus/deficit	(+) 1 415	(−) 731	(−) 1 129
(percentage)	(+) 5.2%	(−) 2.7%	(−) 4.2%

Scenario A	— with capacity addition of 38 369 MW during 1990/91 to 1994/95 as per working group on power)
Scenario B	— with capacity addition of 27 189 MW during 1990/91 to 1994/95 sanctioned and ongoing and CEA cleared projects)
Scenario C	— with capacity addition of 23 308 MW during 1990/91 to 1994/95 sanctioned and ongoing and CEA cleared projects)

SECTION 3

PROPOSED DEVELOPMENT

SECTION 3

PROPOSED DEVELOPMENT

3.1 PROJECT SITE

The site extends from Grid 25 000 W to 4 000 W and Grid 1400 N to 25 S, taking reference from NLC's grid. It is situated to the west of NLC's Thermal Power Station II and to the north west of Lignite Mine II. The railway line to Vriddhachalam passes to the south of the proposed site and there is an existing NLC railway siding on the eastern side. This is indicated in Fig. 3.1. The nearest railway station is 5 km from the site..

The main Cuddalore-Vriddhachalam road will provide the principal access route to the south eastern corner of the site. Living accommodation for site personnel can be located in the south western corner and can be directly connected to the main road.

The site is remote (more than 25 km) from metropolitan cities, ecologically sensitive areas, national parks and wild life sanctuaries. There are no historical, archaeological, cultural, religious or tourist sites of any importance within a 10 km radius.

As the site is remote from the coast and the nearest river is some 5 km away, groundwater will be required for all uses at the site and it is believed that sufficient supplies are available.

3.2 DESIGN OVERVIEW

3.2.1 Plant Layout

It is proposed to install one unit of 250 MW capacity. The power plant will be based on a conventional tower type boiler designed to burn the locally mined lignite, the steam produced will be fed to a steam turbine with a rated output of 250 MW at.

Lignite fuel will be fed from Mine II by belt conveyor and/or road, augmented if necessary by lignite from Mine I which would be carried by road. It is anticipated that stocks of uncrushed lignite will be maintained at the station.

The plant layout is shown in Figure 3.2 and includes provision for extensions of the power station by two similar units. The layout has provision for extension of the power station by two similar units as mentioned below:

(i) Lignite handling - space provision

(ii) Ash handling - provision to increase ash lagoon capacity by raising height of bund

(iii) Fire water system - matched to maximum risk

(iv) Auxiliary boiler - for start up

(v) Central control room - space

(vi) Outdoor substation - extension space

Space has also been provided for retrofit of Flue Gas Desulhpurisation (FGD) plant if it should become necessary in the future.

3.2.2 Fuel Supply and Treatment

NLC have committed to guarantee a total supply of up to 2.0 million tonnes of lignite per year, 1.5 million tonnes per year from Mine II (broadly adequate for this phase of the project) and 0.5 million tonnes from Mine I. Fuel supplies for the first unit would be obtained from either or both of these sources and transported to an on site storage area either by road vehicle transportation (Mine I) or by conveyor belt (Mine II).

The daily consumption of lignite for a 250 MW unit operating at MCR will vary between 6 500 and 7 200 tonnes depending on the quality of the lignite.

A stockpile of approximately 50 000 tonnes working capacity would ensure a seven day buffer stock on worst quality fuel and this would cover an area of around 8 000 m^2 to a depth of 10 metres. This storage space is indicated in Figure 3.2. Space has been allocated for a suitable conveyor or road system and storage area for lignite from Mine I if made necessary by plant extension.

Table 3.1 indicates the guarantee and design range of analyses of the fuel as supplied from Mine II and burned currently at TPS II power plant.

Table 3.2 indicates the analysis range of the worst quality fuel produced at Mine II, which will be burned at the proposed power plant.

An automatic lignite sampling plant will be provided for a quick sampling for analysis, whereby an optimum air fuel ratio can be maintained in combustion for obtaining better efficiency and lower fuel consumption, which in turn is in the best interest of pollution control.

Dust suppression and dust extraction systems will be provided to keep down the dust level to acceptable limits, although it may be mentioned that with high lignite moisture contents of 48% and above both problems are not anticipated.

It is intended that heavy fuel oil will be used as the combustion support fuel and 2 x 1 500 m^3 storage tanks and handling facilities for road tanker deliveries are include in the project scope. The fuel oil storage area will be protected by safety measures as required by the Indian Explosive Act. Proper oil containment and recovery system for drains from the storage area will be provided to prevent oil or sludge escapes to water courses.

3.2.3 Power House

3.2.3.1 Turbine Generator Unit

The steam turbine will be tandem compound single reheat, regenerative condensing, multi-cylinder design. The steam turbine will be directly coupled to a 3 phase, 50 Hz, 300 MVA, hydrogen cooled generator. The generator voltage will be rated at 16.5 kV or more as per practice of manufacturer. A circuit breaker will be provided for the generator (on 16.5 kV side). A static excitation system will be provided for the generator.

The turbine will be designed for the following conditions and will be suitable for sliding pressure operating below 80% load.

Pressure of main steam at throttle : 176 kg·cm^2
Temperature of mainstream at throttle : 538°C
Temperature of reheat steam at throttle : 538°C
Cooling water inlet temperature to condenser : 39°C
Turbine exhaust pressure : 0.1033 kg/cm^2

The turbine generator will be equipped with a completely self contained lubrication oil system, hydraulic control system, generator seal oil system, etc. All usual protective devices and special devices typical for latest unit of this size and type will be provided. The turbine will have six uncontrolled extractions to supply steam to the regenerative heating system, including deaerator, sealing steam, ejector steam, etc. The feedwater temperature at the outlet of final HP heater will be 240-260°C between 150-250 MW. 3 x 50% electrical boiler feed pumps shall be provided for pumping feedwater from deaerator storage tank through the HP feedwater heaters to the boiler.

The boiler feedwater pumps will have variable speed hydraulic couplings.

Steam air ejectors will be provided for air extraction.

The condenser will be of divided water box construction with integral air cooling section. Stainless steel will be used in the condenser as well as other feedwater heat exchangers to avoid copper pick up. On load rubber ball cleaning system will be provided. The difference of temperature between the inlet and outlet cooling water will be about 8°C.

A 40% HP/LP steam bypass system will be provided.

3.2.3.2 Transformers

a) Generator Transformer

A 3 phase, 50 Hz, 250 MVA Delta/Start 16.5 kV/240 kV OFAF transformer will be employed to connect the unit to the power grid.

B) Unit and Station Transformers

Unit and station transformers of requisite capacity will be provide. The LV voltage side of these transformers will be typically rated at 6.9 kV.

c) LT Transformers

The requisite number and capacity of LT transformers 6.6 kV/415 V will be provided for the station.

3.2.3.3 Steam Generator

A direct pulverised lignite fired, single reheat, single pass (tower type) balanced draught, boiler working at subcritical pressure is envisaged.

The capacity of the boiler will match 250 MW electrical output from the turbine-generator set. The pressure and temperature of the boiler will be such that the steam conditions at the turbine throttle are 176 kg/cm^2, 538°C. Feedwater inlet condition will be 240°C-260°C and flue gas stack outlet temperature will be around 150°C.

3.2.4 Chimney Design

It is intended to construct a single flue stack 220 m in height and around 5 m diameter at the flue gas exit and 13 m bore, as required by the Environmental standards set by the Ministry of Environment and Forests, India.

The chimney will be self-supporting with an outer shell. The flue can be of (suitably supported) steel or refractory brickwork. Usual lightning protection, aviation lights, maintenance facilities will be provided.

3.2.5 Water System

All water supplies to the station will be from groundwater supplies taken from 8 or 9 tube wells sunk in the immediate area, with an emergency connection to a lake-water system having a capacity of 48 hours supply to cater for fluctuations in demand, emergencies, etc.

The raw water supply will be treated by passage through clarifiers, filters and ion exchange processes to produce a range of water qualities suitable for use on site. Tanks will be provided for storage of clarified water, filtered water, potable water and demineralised water.

It is intended to use closed cycle cooling water circuits to minimise consumption which is anticipated not to exceed 1 535 m^3/h as detailed below:

			m^3/hour
(i)	Make up to CW system		120
(ii)	Service water		100
(iii)	Water treatment plant		90
(iv)	Make-up to ash water system		125
(v)	Others		100
		Total	1535

Ensuring that all re-usable water is recycled in the plant enables minimisation of the rate of raw water abstractions and reduction in the problem of effluent disposal.

Regeneration of the ion exchange resins will be carried out by using sodium hydroxide and strong mineral acids which will be stored in segregated bulk storage tanks, suitably sized for deliveries by road tanker.

All effluents from the water treatment plant will be neutralised before being pumped to the ash handling system for subsequent re-use.

Hot water from the cooling cycle will be blown down to the ash handling system. No hot water is directed to the drains and therefore no thermal pollution is expected.

3.2.6 Power Transmission

The entire power output of this first unit is expected to be taken by TNEB. The station will be connected to the 230 kV grid by loop-in and loop-out of existing lines between Neyveli TPS II and substations at Perambular and Attur.

3.2.7 Landscaping and Architecture

Landscaping will be needed to achieve the following objectives:-

(i) To provide green cover for the ash pond

(ii) To provide rows of trees on roads

(iii) To provide green cover on all available vacant land following construction

(iv) Lawn and gardens to be laid out in the project area and in the colony

(v) Fruit trees would be preferred with a selection achieved using conventional horticultural and forestry techniques.

3.3 ENVIRONMENTAL PROTECTION MEASURES

3.3.1 Atmospheric Emissions and Emission Control

3.3.1.1 Background

About 1.3 x 10^6 Nm^3/h of flue gas will be released at a temperature of 150°C and having a density of 1.24 kg m^3 at normal temperature and pressure (NTP). The main flue gas constituents will be CO_2, N_2, CO, O_2 and SO_2. The heat emission rate associated with these gases will be 32 x 10^6 kcal/h.

All the emissions from the plant are proposed to be controlled to meet the relevant standard set by the Bureau of Indian Standards and relevant pollution control authorities.

A modern, almost completely automatic plant, with extensive pollution control and monitoring measures is envisaged.

3.3.1.2 Particulate Matter Emissions

A high efficiency electrostatic precipitator (ESP) will be installed for the gas cleaning in order to limit the particulate matter emissions to 100 mg/Nm^3 at MCR when the worst fuel quality is adopted. Even with one field of the ESP out of service, the emission level will be limited to 130 mg/Nm^3 as per design. This compares with a prescribed limit of 150 mg/Nm^3.

A microprocessor based, programmable type, rapping control system and an ESP Management System will be provided to ensure optimum safety and efficiency.

The . limit at 150 mg/Nm^3 is fixed as per Indian Emission Regulations (July 1984) and Environment Protection Rules (1986) Rule 3, Schedule 1 (and all subsequent revisions). The plant will comply is designed to comply with the regulations under all conditions. Monitoring of suspended particulate matter will occur using high volume samples.

3.3.1.3 Emissions of Oxides of Sulphur (SO_x)

The estimated emission rate of SO_x will be 3-4 t/hr; this will be monitored. The regulation specifying the minimum height of chimney as 220 m for units between 200 MW and 500 MW to take care of SO_x emissions will be followed strictly. This is as per Environmental Protection Rules 196, Rule 3, Schedule 1 and Indian Emission Regulations (July 1984). As per estimation SO_2 will not exceed 100 tonnes per day for 250 MW units.

The maximum ground level concentration of SO_2 (8 hourly samples) will be within the permissible limits in existing regulations.

Space for a Flue Gas Desulphurising Plant has been provided for in the layout should future retrofitting prove necessary.

3.3.1.4 Emissions of Oxides of Nitrogen (NO_x)

Although there are no guidelines provided by the Indian Pollution Control Authority for NO_x levels, the design will incorporate low NO_x type burners and low furnace temperatures which suppress NO_x production considerably. No problem is envisaged with this design and NO_x emissions will not exceed 650 mg/Nm^3. This level is accepted by the European Community (EC).

3.3.1.5 Lignite Dust Disposal in The Atmosphere

As the project will be sited near the mouth of the lignite mines, no increase in lignite dust dispersal is envisaged. Moreover, lignite is a high moisture fuel with a typical value of around 48% moisture and thus dust generation during handling is very low. However, tunnels and sensitive areas will be provided with dust suppression and extraction systems.

3.3.2 Liquid Waste Management

3.3.2.1 Washings and Occasional Water

(a) Plant Washings

Plant washings containing any ash or lignite dust will be led to ash channels. Floor washing will also be led to ash channels.

(b) Treatment of Effluents from Water Treatment and Condensate Polishing Plants

All the effluents from the water treatment plant and condensate polishing plant will be neutralised and treated by adding caustic soda/lime before release to drains which are directed to the ash handling system for disposal/utilisation.

(c) Boiler/Cooling Tower Blowdown

This will be released to ash slurry trenches where it mixes ash and large quantities of water thus dispersing the unacceptable heat and diluting the levels of alkalinity.

(d) Lignite Stock Yard Drainage

The lignite stock yard will be sloped properly with a filter layer. Only 7 days stock will be kept thereby reducing problems of leaching from the stockyard.

3.3.2.2 Surface Drainage

The surface drainage will be led to the existing water way (Nalla) and no treatment is necessary.

3.3.2.3 Sewage

The sanitary sewage from the residential and plant area will be treated in septic tanks as per standard practice.

3.3.2.4 Oil Contaminated Waste

This will be led to oil decanting facilities where oil and sludge will be separated from the water with the latter only being released to drains after the quality has been ascertained.

3.3.2.5 Ash Pond Effluent

The expected characteristics of the ash pond effluent are as shown in Table 3.3.

3.3.3 Solid Waste Management

3.3.3.1 Ash Management

Ash from the power station will be disposed of in the form of slurry in the bunded Ash Dump Yard. Here the ash will be retained and the decanted water recycled. Quantities of ash produced per day will be 160 t/unit of bottom ash, 440 t/ash unit of fly ash.

Table 3.4 indicates the likely range of ash composition. Bottom ash which is 20% of the total ash generated will be removed by a hydrojet system while fly ash removal will be either by vacuum or a pressurised pneumatic system. Both fly ash and bottom ash will be converted to a wet slurry and pumped to the ash dump yard. The location of this is shown in Figure 3.1.

The ash content from the lignite varies from 3% to 12% with an assumed annual average of 8.84%. It is intended to allow sufficient capacity in the ash dump yard for a period of 6 years operation with provision for extension.

Further land will be obtained from the available 75 hectares nearby on the north side of the proposed site and utilisation methods will be explored.

The utilisation of ash will be undertaken in consultation with NLC. Encouragement will be given to the parties to make construction blocks and bricks, utilising the ash. Cement manufacturers will be encouraged to use fly ash as a polozonic material. Land reclamation initiatives in the surrounding area should also be encouraged to use ash.

All abandoned ash dumps will be covered with 0.5 to 1 m of top soil to ensure that the land can be used as pasture or for the growing of crops.

Selected forestation of this land will also be undertaken as some varieties of trees can be planted on this dump in small pits filled with soil and manure. There could be a possible risk of contamination by heavy metals (see Sections 9 and 10).

3.3.3.2 General Waste

General waste, including building materials, scrap metals and colony waste will be sent to an appropriate disposal source.

3.3.4 Noise

All equipment will be designed and operated to have a noise level to comply with the World Bank's guidelines outlined earlier.

3.3.5 Fire

All equipment vulnerable to explosion or fire will be designed to the relevant IS codes and statutory regulations.

The power station will be protected by an extensive fire detection and alarm system with hydrants covering the entire project area and specific systems for particularly vulnerable areas such as coal conveyors etc.

3.3.6 Alternative Protection Measures

Any alternative protection measures identified as a result of the environmental monitoring or management plan will be installed. These might include such features as bunds located around transformers and the fitting of locks to valved drains.

3.4 CONSTRUCTION OVERVIEW

3.4.1 Materials, Intermediate Products and Final Products

Equipment will be transported to site by rail and road; the nearest railway station where materials will be off loaded is Umangalam. No extra land will be needed for the construction of roads.

3.4.2 Releases to the Environment

During construction the principal releases to the environment will be dust and particulates.

3.4.3 Environmental Alterations

There will be very little environmental alterations during construction as the area has little natural vegetation. The main impact will be soil compaction due to the use of heavy machinery.

3.5 PROJECT TIME SCALE

The 250 MW unit is stated to be commissioned within 36 months from the start of civil work for the plant.

Table 3.1

Guaranteed and Design Range Of Analyses of Fuel supplied from Mine II

Proximate Analysis

	Design	Guarantee
Moisture (%)	44 to 57	48
Ash (%)	2.5 to 12	8.84
Volatile matter (%)	22 to 27	24.6
Fixed Carbon (%)	17 to 22	18.56
Gross Calorific Value (kcal/	2500 to 3200	2678

Ultimate Analysis

	Design
Moisture (%)	44 to 57
Ash (%)	2.5 to 12
Carbon (%)	27 to 34.27
Hydrogen (%)	2.2 to 2.94
Sulphur (%)	0.46 to 0.81
Nitrogen (%)	0.2 to 0.34
Oxygen (%)	8 to 14

Hardgrove Index design value = 115 to 125

Ash fusion temperatures:–

	IDP	BP	FDP
Maximum (°C)	1210	1300	1300
Minimum (°C)	940	1240	1300

Note: The quality of lignite supplied from Mine I is envisaged to be of a similar quality.

Table 3.2

'As Recieved' Fuel Analyses – Worst Case Condition (Mine II).

Proximate Analysis

	Maximum Moisture	Maximum Ash	Maximum Volatile
Moisture (%)	56.00	46.80	54.10
Ash (%)	2.80	10.00	5.30
Volatile Matter (%)	23.00	25.40	22.00
Fixed Carbon (%)	18.20	17.80	18.60
Gross Calorific Value (kcal/kg)	2541.00	2750.00	2578.00

Ultimate Analysis

	Maximum Moisture	Maximum Ash	Maximum Volatile
Moisture (%)	56.00	46.80	54.10
Ash (%)	2.80	10.00	5.30
Carbon (%)	26.30	28.22	26.67
Hydrogen (%)	1.95	2.36	2.20
Sulphur (%)	0.43	0.76	0.57
Nitrogen (%)	0.27	0.07	0.30
Oxygen (%)	12.25	11.79	10.86

Table 3.3

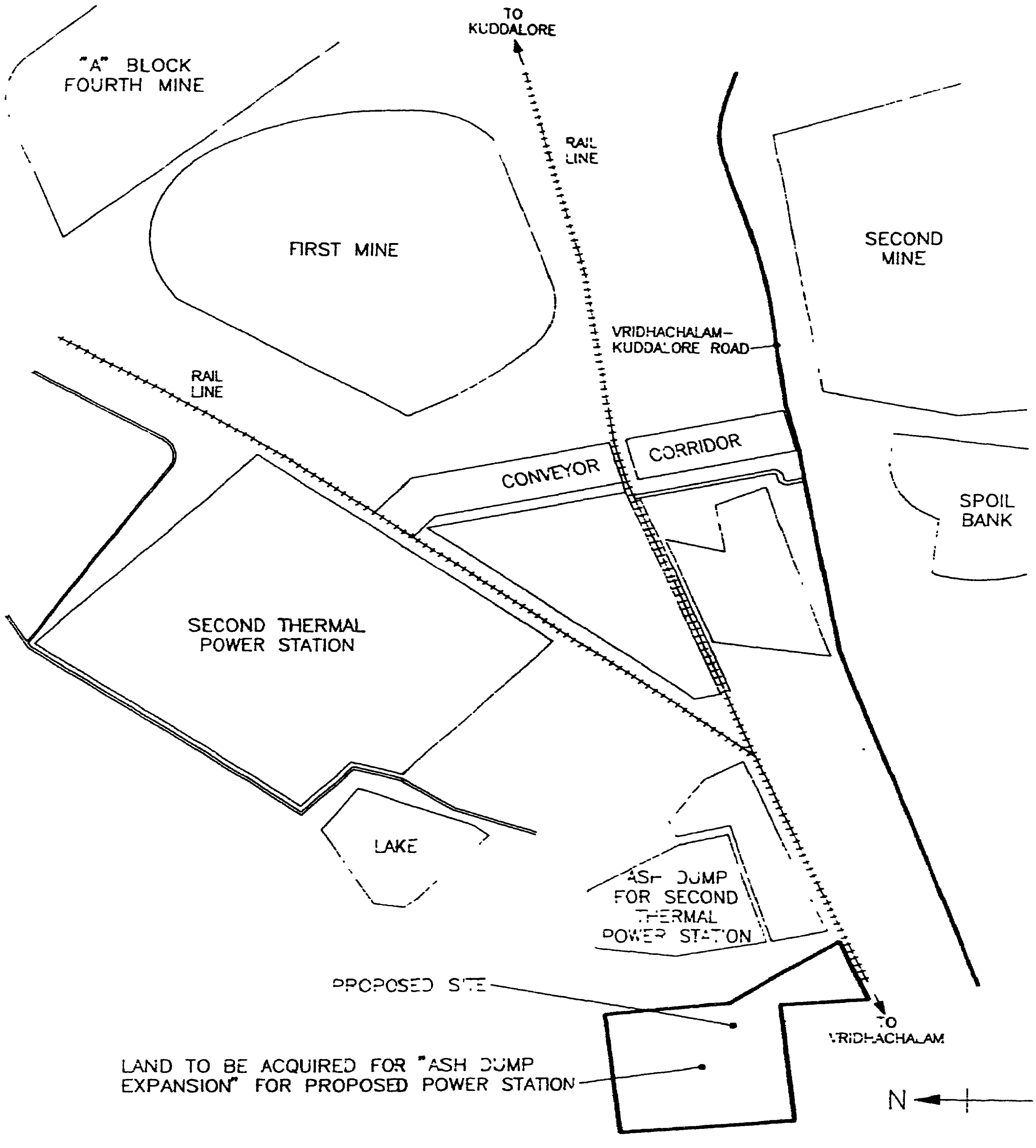
Expected Characteristics of Ash Pond Effluent

Constituent	Concentration (mg/l)
Calcium as Ca	36.0
Magnesium as Mg	14.6
Sodium and Potassium as Na	38.2
Iron and Aluminium oxide as R_20	5.6
Iron as Fe	0.1
Silica as $Si0_2$	56.8
Chloride as Cl	41.0
Sulphate as SO_4	95.4
Free CO_2	Nil
Total Solids	365.5
Dissolved Solids	272.5
Suspended solids	93.0
Bicarbonate alkalinity	52.0
Carbonate alkalinity	24.0
Hydroxide alkalinity	Nil
Total hardness	150.0
Temporary hardness	76.0
Permanent Hardness	74.0
pH (at room temperature)	8.7
Chemical Oxygen Demand	16.0

Table 3.4

Range of Ash Composition

Constituent	Maximum (%)	Minimum (%)
$Si0_2$	52	28
Fe_20	22	8
Al_20_3	30	7
$Ca0$	15	8
$Mg0$	5	1
$S0_3$	26	9
$Ti0_2$	0.11	0.07


TO KUDDALORE
"A" BLOCK FOURTH MINE
RAIL LINE
FIRST MINE
SECOND MINE
VRIDHACHALAM-KUDDALORE ROAD
RAIL LINE
CONVEYOR CORRIDOR
SPOIL BANK
SECOND THERMAL POWER STATION
LAKE
ASH DUMP FOR SECOND THERMAL POWER STATION
PROPOSED SITE
LAND TO BE ACQUIRED FOR "ASH DUMP EXPANSION" FOR PROPOSED POWER STATION
TO VRIDHACHALAM
N

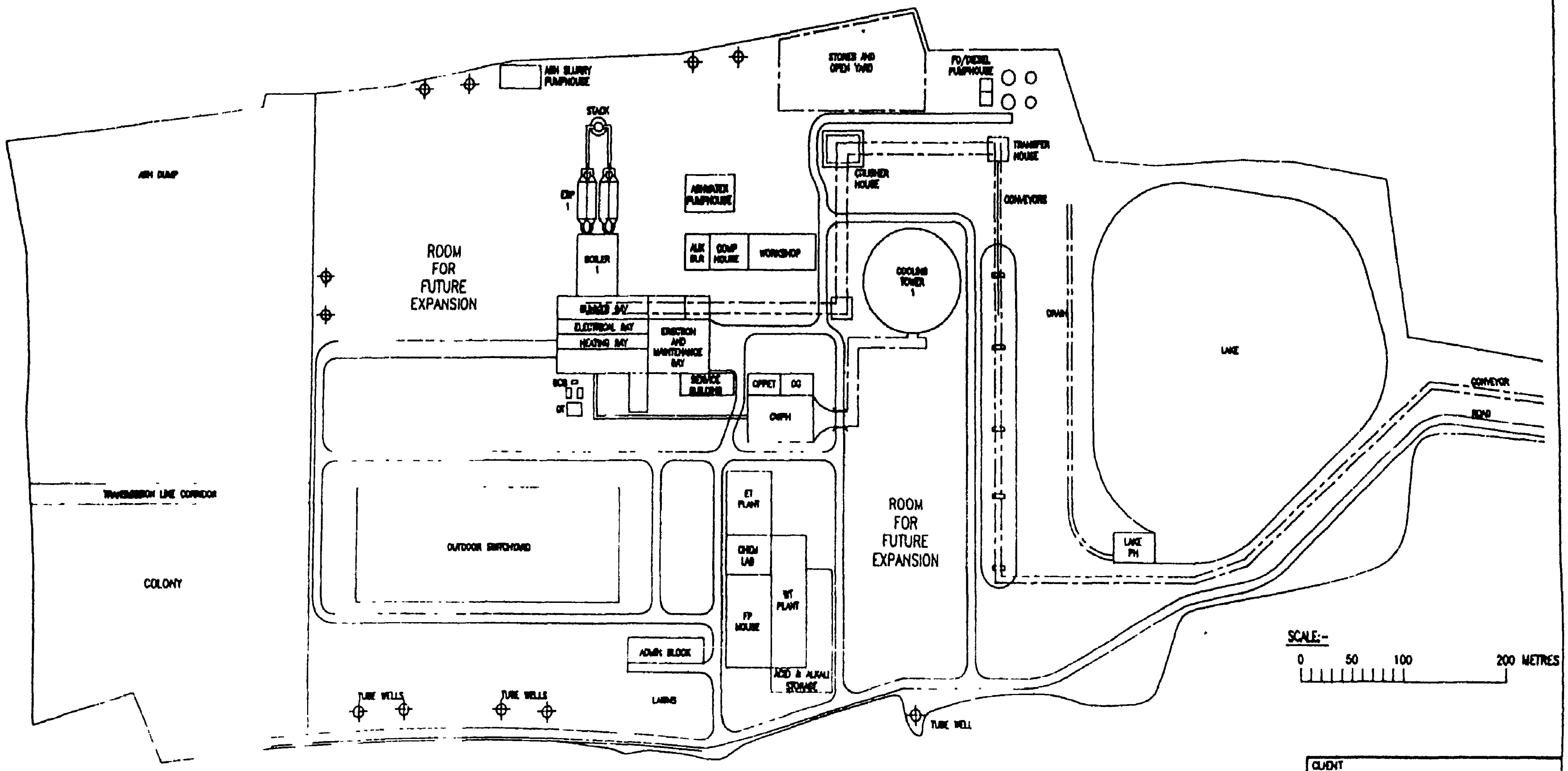
LOCATION OF THE PROPOSED SITE

EWBANK PREECE

96402

FIG. 3.1

DRAWN BY AUTOCAD



KEY:-

- - - - INITIAL PHASE
CPPET CONDENSATE POLISHING EFFLUENT TREATMENT PLANT
DG DIESEL GENERATOR
FP HOUSE FIRE PUMPHOUSE

CLIENT:	ST POWER SYSTEMS INC
JOB:	NEYVELI
TITLE:	PLANT LAYOUT

Ewbank Preece Limited

SECTION 4

EXISTING ENVIRONMENT - PHYSICAL

SECTION 4

EXISTING ENVIRONMENT - PHYSICAL

4.1 INTRODUCTION

The proposed site is situated 12 km west of Neyveli town and 4 km north of the main Cuddalore-Vriddachalam road.

There are a number of industries within 10 km of the site based mainly on the presence of the lignite field, they include:-

- Thermal power station No. I (600 MW)
- Thermal power station No. II (7 x 210 MW)
- A fertiliser plant
- A lignite briquetting plant

The topography of the land is generally flat, being between 50-60 m above sea level. Drainage runs towards the south where a natural lake has formed.

Vegetation in the region is coarse and the area contains no prime agricultural land. It is characterised by a lack of estuaries with no national monuments, wildlife sanctuaries or ecologically sensitive sites.

The only cultural/historic/tourist/archeological sites are the following:

● A Roman Catholic church at Neyveli Township:	13 km
● Samadhi of Sri Ramalingasamy at Vadalur:	13 km
● A Vashnavite Temple at Srimushnam:	19 km
● A Srarte Temple at Vridhachalam	13.5 km

However, an number of industries are situated nearby:-

- 600 MW Thermal Power Station No 1 at a distance of 10 km from the site.

- 7 x 210 MW Thermal Power Station No. 1 II at a distance of 3 km from the site.

- A lignite Fertiliser Plant based at a distance of 10 km from the site.
- A briquetting plant at a distance of 10 km from the site.

4.2 CLIMATE

Being located in south east India the climate is characterised as a monsoon type climate as indicated by Table 4.1 showing the typical wind reversal pattern from SW (April to October) and NE (October to April) associated with monsoon weather. Maximum recorded wind velocity is 144 km/h.

Typical maximum and minimum temperatures for Neyveli are shown in Table 4.2 with the range being between 18 and 43°C.

The average annual rainfall is 1214 mm with a maximum intensity of 120 mm in one hour and 338.6 mm in 24 hours.

The minimum recorded relative humidity is 19% which rises to a maximum of 95% between October and December and from May to July. The average relative humidity is 65.2%.

4.3 RELIEF AND DRAINAGE

The topography of land is generally flat. The contours shown on the site map clearly show this. The drainage runs towards the south and a natural Nalla is available as shown in Figure 4.1. There is no river nearby.

4.4 GEOLOGY AND SOILS

Although there has been no detailed soils or geo-technical investigations carried out on the site, investigation reports prepared by NLC for the foundation designs of TPS II in 1985 indicate that:-

- the top 2 metre layer consists of loose sand
- the next 8 metre layer is yellowish brown lateritic clay of very stiff to hard consistency
- soft rock is encountered at 10 metres depth

The bearing capacity of soil at 3 metres depth varies between 18-30 t/m^2 and there seems no difficulty in locating heavy foundation structures as NLC have similar structures and foundations in the area close by. The bearing capacity of soil at 3 metres depth varies between 18 to 30 t/m^2. It is anticipated that no rock blasting would be involved and that piling of the area would not be necessary.

Detailed geotechnical or hydrological soil investigations will be carried out on the actual site to confirm the basis for civil engineering design.

4.5 SEISMIC ACTIVITY

The area falls within seismic zone no. II as defined in I.S. 1893 dated 1984 (criteria for earthquake resistant design of structures).

4.6 HYDROLOGY AND HYDROGEOLOGY

4.6.1 Ground Water

4.6.1.1 Abstraction

The proposed power station is near the NLC's TSP-II. The formations of upper Miocene age (tertiary) with its vast potential of ground water and lignite cover most of the Neyveli area, and in the south, the alluvial soil of rivers Vellar and Manimuktar overlain as top layer.

The sub-surface structure of the Guddalore formation, projected from available boreholes data, indicate a synclinal basin. The water bearing unit of "the Guddalore's" is not out-cropping anywhere in the Neyveli area. The total thickness of water bearing sands extends to more than 370 m in the central portion, pinching to 50 m in the west and east.

The aquifer material is made up of medium to coarse grained quartz sands and the clay beds in the sands compartmentalise the aquifers with different pressures and parameters. Pump tests conducted earlier on the top 50 m of the aquifers, designated as upper aquifer, showed a 'T' value of 1748 sq m/day and 'S' value of 2.87×10^{-5}. After 30 years of prolonged pumping in the present pumping zone of the mine, from the observation of water levels and ground water pumpage, it is estimated as 900 sq m/day and 1.4×10^{-1} respectively, which has also been confirmed by computerised water level data analysis.

The total ground water potential, as inferred from the thickness of aquifer strata of the basin, is of the order of 96 000 million m^3. The confined ground water in the interstices of the sand grains comprising the aquifer which is 40 to 50 m thick, exerts an upward pressure of 50 to 100 tonnes/m^3 due to its hydrostatic head of about 30 m above mean sea level (MSL) in the mining area. The water pressure is reduced and pressure head maintained constantly below the lignite seam by continuous pumping operations to extract the lignite safely. Due to the mining operations which have been going on for 30 years, the original pressure head (static pressure surface), which was around 30 m above MSL in the mines, has now depressed almost to 50 m below MSL, i.e. to the bottom of the lignite seam.

4.6.1.2 Impact of the Lignite Mines I and II

For the extraction of lignite using surface mining technique, it is necessary to lower the ground water level to prevent collapse of slopes of the mine and also to prevent flooding of the lignite bed. Around 100 million gallons/day (MGD, 2404 m^3/day) of ground water are being pumped through production wells from the aquifer for ensuring safe mining in the two mines. NLC's total water requirement is met through ground water pumped out of Mines I and II at the rate of 159.17 m^3/min and 140.83 m^3/min respectively. Hydrological information from pumping tests have been used in successfully developing a depressuring system for the two mines. The annual requirement of NLC's industrial units and township together is around 115.32 million m^3.

The pumping operations in these mines were commenced in July 1961 with an initial discharge of 24 000 gallons per minute (GPM) in Mine I. This discharge was gradually stepped up to 50 000 GPM in stages in July 1964 and at present it is being maintained around 35 000 GPM. The pumping operations are being carried out around-the-clock since its uninterrupted operation for the last three decades. Also in Mine II, similar pumping operations were started in December 1982 and at present a discharge of about 30 000 GPM is being maintained providing adequate safety at the points of excavation.

Since the commencement of pumping operations in both mines, nearly 2 300 million m^3 of water has been extracted from the ground water reservoir.. Annually, nearly 115 million m^3 of water is being pumped for ground water control measures and apart from this, another 60 million m^3 is being extracted for other uses such as irrigation, etc.

Hydrographs depicting the ground water contours of the regional groundwater modelling, Neyveli basin, are attached as Appendix C.

4.6.2 Surface Water

4.6.2.1 Background

There is no one large perennial source of water in and around the proposed site. Other water bodies close to the proposed project are the rivers Manimukthar and Vellar in the Vridhachalam taluk. There are two reservoirs: the Vridhachalam anicut and the Wellington reservoir. Two lakes in the proximity of the project are Jambu Eri and Periyar Eri. However, the only source of water for the NLC complex is the ground water pumped out from the lignite mines I and II. Besides the project in question, there have been extensive industrial activities in the region which have had direct and indirect impacts on the water environment. Impact of other industrial activities on the water quality is explained below.

4.6.2.2 Impacts from Thermal Power Stations I and II

In TPS I and TPS II, the main effluents are the supernatant water from ash pond and the rinse discharge from the water demineralisation plant. The bottom ash and slag from the boilers are mixed with water and the slurry is taken to large ash ponds covering an area of 63 ha. The effluents from the boiler blow down, chemical treatment plant (coming out of regeneration rinsing and backwashing), also joins the slurry. The ash and slag get settled in the ash pond and only clear supernatant water is allowed to overflow and join the common stream. Thus, the quality of this effluent at the point where it is discharged to the stream is within the effluent standards specified by the Tamil Nadu Pollution Control Board (TNPCB).

4.6.2.3 Fertiliser Plant

The effluent from the fertiliser plant is slightly high, occasionally. in ammonical nitrogen and suspended solids, especially when there are disturbances in plant operation. This is, however, sufficiently diluted later when the effluent from the TPS I. B&C plant and the process steam plant also join it. In order to reduce the ammoniacal nitrogen in the urea plant effluent, schemes are being actively designed to introduce modifications to remove ammonia from the discharge water before despatch.

4.6.2.4 Briquetting and Carbonisation (B&C) Plant

In the B&C plant, the fine carbon dust in the cooling gas from the carboniser plant is recovered by scrubbing with water and sending it to the sludge pits where the recovery is effected by scrapers and the recovered water is used for scrubbing operations. The coke dust is slurried with water and let out to pits wherefrom the dust is recovered. The effluent from the tar product plant consists mainly of phenols and a biological treatment plant is being commissioned for controlling the phenol content in the effluent.

Recognising the need and importance of environmental management in the NLC complex, Centre for Applied Research and Development (CARD) initiated its water quality monitoring and effluent sampling work. CARD is an organisation owned by Neyveli Lignite Corporation. As overall maintenance of water quality in a region is the combined responsibility of all the industrial units, CARD's efforts need to be mentioned here.

4.6.3 Existing Water Quality Monitoring

The effluent discharged from TPS I and II, the fertiliser plant and B&C plant combine together and travel through the protected area of NLC. CARD regularly monitors the effluents from individual units, and also the combined effluent leaving the NLC limits. In order to achieve their objective of total environmental management, NLC has given due attention to the maintenance of water quality as per the required norms. The effluents from the various industrial units are subjected to proper treatment before being discharged into inland surface waters.

Combined effluent from the NLC industrial complex is mainly let out and used for irrigation in the villages surrounding the NLC complex. To assess the quality of the water used for irrigation, water samples are periodically collected from different locations where NLC's surplus water is flowing and analysed at the CARD laboratory with particular reference to its use for irrigation purposes. The samples are tested for total dissolved solids (TDS), electrical conductivity at 22°C, potential salinity, residual carbonate, sodium percentage, sodium absorption ratio (SAR), permeability index, and boron content. It has generally been found that, based on the analysis results, the water samples can be classified as Class I, i.e. ranging from good to excellent, with respect to agricultural use.

4.6.4 Water Quality Studies for the Proposed Plant

4.6.4.1 Water Requirements

Condenser Cooling Water

There are no rivers or lakes in the vicinity of the power plant from which supplies of water can be drawn for the proposed plant and therefore once through cooling water system cannot be considered as a practical option for the proposed plant. A similar situation was encountered with the existing NLC's TPS II power plant which utilises a closed cycle evaporative tower type cooling water system, and draws make-up water form the ground water disposal line coming from the lignite mines. The 1987 feasibility study for the NLC's Zero Unit considered supply of water (its total make-up water) from the pumped ground water coming from the lignite mines. This option is, however, not available for the proposed plant because NLC is not able to make a commitment to supply water across the site boundary the only viable option for the closed cycle evaporative cooling system of the new plant appears to be the utilisation of the tube wells specifically bored for the purpose.

Typical analysis of the tube well water is given in Table 4.3.

Raw make up water for the cooling water system will be supplied from ground water sources using tube wells. There will typically be about 8 or 9 tube wells each of 250 tonne/h capacity spread over the plant and non plant areas within the site boundary. There would also be a need to create an artificial lake on the site for storing 7 day buffer store of water. Assuming the depth of water in the lake is of the order of 6 to 7 m, the lake would occupy an area of approximately 50 000 m^2. The level of buffer stock and the alternative use tanks instead of a lake to store a smaller reserve of water is subject to further review.

The estimated total quantity of make-up water for the proposed new unit is 1800 t/h under normal operating conditions. In the event that there was no recirculation of water in the ash disposal system, this figure would rise to approximately 2700 t/h. A request has been made by the proponents to NLC to get the ground water availability survey carried out by the Central Ground Water Board (CGWB) and obtain their clearance for extraction of the above quantities of water from the tube wells. In case of limitations in availability of this quantity of water, it would be necessary to consider the use of dry or combined wet/dry cooling systems as alternatives to the preferred evaporative cooling tower system and also to adopt a dry ash handling system.

For the plant cooling water systems, typically three 50% duty CW pumps will be provided to supply water for the main condenser and auxiliary plant cooling purposes. The pumps will draw their supplies from the pond associated with the evaporative cooling tower. The cooling tower may be of either natural or force draught design. The natural draught option is preferred as it has lower losses when compared with the forced draught option. The cooling water system will also be provided with a chlorination plant to control growth of algae and bacteria in the system.

On the assumption that there are adequate make-up water resources for an evaporative cooling tower system, the condenser will typically be of the divided water box construction with an integral air cooling section. The rise in cooling water temperature will be approximately 8°C. The condenser tubes will be of suitable materials to avoid problems arising with copper pick up by condensate. The condenser will be provided with an on load rubber ball cleaning system.

A close circuit cooling water system will be adopted for the steam turbine generator and common auxiliaries. The closed circuit will operate on fresh water which in turn will be cooled in two 100% duty heat exchangers by water drawn from the CW pumps.

In view of the limited water resources available at the site, the total water cycle has been designed in such a way that all the usable water is recycled in the plant. The recycling system will include (1) recirculation of water within the ash disposal system, (2) recycling of treated effluent from the water treatment plant for its use as make-up water for the ash disposal system, and (3) all clear water drains from plant will lead to either the ash system or the lake, depending on the proximity. All boiler blow down water and other drains which are not otherwise usable will be led to the ash system.

Other Water Requirements

In addition to condenser cooling make-up, water is also required for (1) ash disposal, (2) raw water to provide the demineralised water requirement for steam cycle make-up, and (3) miscellaneous uses including auxiliary cooling services, plant washing, air conditioning, soot blowing, fire fighting, and drinking water. Again, these will have to be sourced from the tube wells and the demands are to be taken into account in the determination of water availability for the evaporative cooling tower system.

Water Treatment Plant

A range of water treatment plant facilities are required to meet the varying plant needs for demineralised and filtered water. The pretreatment plant, which will have sufficient capacity to meet the total requirements for filtered, demineralised and potable water will draw water from the tube well system and will comprise 2 x 100% duty streams of pressure gravel filters, with alum dosing and back wash facilities. The pretreatment plant will discharge its product water into filtered water storage tanks which will act as a buffer supply to the filtered water system, boiler make-up water, demineralisation and potabilisation plants.

Filtered water will be used for general services including plant wash down, etc. The demineralisation plant will supply boiler make-up water and will be designed to provide an output equivalent to 4% of boiler MCR. Each stream is anticipated to comprise an activated carbon filter, cation exchanger(s), degasser system (comprising degasser tower, degassed water tank, degassed water pumps, blowers for degasser, etc.), anion exchanger(s), mixed bed exchanger. The cation resins will be regenerated with hydrochloric acid and the anion resins with sodium hydroxide. The generation facilities will include bulk acid/alkali storage tanks, solution preparation tanks, dosing pumps, etc.

One 500 m^3 demineralised water storage tank will be provided as a buffer storage for boiler make-up water with bypass for demineralised water to be supplied direct to the reserve condensate tank.

A potabilisation plant will be provided to meet the needs for drinking water on the site as well as in the staff colony.

4.6.4.2 Sea Water Intrusion

As the site for the proposed project is close to the sea and since extensive ground water extraction is going on in the area (for lignite mining), there is a possibility of sea water intrusion in case the water table goes below the MSL. This possibility was studied in detail and the information available with NLC on this aspect was collected. NLC has been regularly monitoring, over the last two decades, the chemical quality of the ground water by systematically collecting samples from a network of boreholes spread over an area of 3000 km^2 including the coastal area. These tests have already indicated that there is absolutely no salt water contamination, e.g. Cl/CO3 + HC03 ratio which is one of the diagnostic factors for salt water contamination, has been consistently less than one, indicating no contamination. These ratios from the latest analysis of the samples collected from some of the observation wells located in the recharge as well as discharge are depicted in Figure 4.2. A perusal of the graphs show that there is neither any progressive increase in the ratio towards the sea coast nor any deterioration in the quality with reference to the time along the coast, thereby ruling out any salt water intrusion.

4.6.4.3 Water Quality Studies for the Proposed Plant

We have conducted water quality monitoring for the assessment of baseline water quality in the region. For this purpose, water samples were collected from five surface water bodies and three borewells in the vicinity of the proposed site. The water quality monitoring stations are indicated in Figure 4.3. The water samples were collected from:

1. Pond water (perennial) at Umangalam
2. Pond water (seasonal) at Uthangal (near the proposed site)
3. Pond water (perennial) at Chakkarakulam (near Edakuppam)
4. Pond water (perennial) at Kunankurichi (near TPS II)
5. Pond water (perennial) at Vrithakirikuppam (near Mudhanai)
6. Bore well water (420 feet) at Kamapuram
7. Bore well water (450 feet) at Uakaram
8. Bore well water (350 feet) at Arasakuzhi

The results of the analysis are given in Table 4.4.

The effluent samples (due to existing industrial units) were taken from two major effluent sources in the vicinity which are ash pond effluents from TPS II, Stage I and Stage II. The effluent samples were test as per IS-2488. The effluent samples were collected from:

1. Effluent water (ash pond overflow and lake water) TPS II Stage I stream.

2. Effluent water (ash pond overflow) of TPS II Stage II stream.

The results of the analysis are given in Table 4.5.

4.7 AIR QUALITY

4.7.1 Background

The Neyveli Lignite Corporation Limited is an integrated complex comprising of Mine I (6.5 mt/y) and Mine II (4.7 mt/y), pit head thermal power station I (TPS I, 600 MW) and thermal power station II (TPS II, 7 x 210 MW), a fertiliser plant producing urea (1 29 200 t/y), and a briquetting and carbonisation plant production lignite coke (2 62 000 t/y). Lignite extracted from mines is used in TPS I and II for generation of power, and in the briquetting and carbonisation plant for the production of coke. The fertiliser plant uses low sulphur heavy stock (LSHS) as the feed stock for the production of urea.

From the first stage, i.e. lignite extraction, to its utilisation and the final disposal (of ash), all the operations are carried out by NLC. These operations result in the emission of air pollutants which are to be effectively controlled to protect the air quality of the area. NLC has, therefore, taken adequate steps for the pollution control as per the requirements of the Tamil Nadu Station Pollution Control Board (TNPCB) and the Ministry of Environment and Forests (MoEnv&F), Government of India. The NLC has set up Centre for Applied Research and Development which is responsible for all activities related to environmental monitoring and management. CARD has been conducting air quality monitoring in the NLC complex since its inception. Details of some of the air quality management work done by CARD is presented here.

4.7.2 Existing Air Quality

4.7.2.1 General

In order to assess the ambient air quality, CARD has set up number of permanent air quality monitoring stations (8 no) in accordance with the IS 5128 (Part III), and Central Pollution Control Board's (CPCB's) norms (Emission regulations, Part II). The selection of the monitoring locations was done on the basis of windrose (depicting frequency distribution of the wind direction and speed) for the area and the source characteristics. The sampling locations are ideally located so as to cover the Neyveli area around the thermal power stations and chemical plants. The monitoring at all the locations is being carried out on alternative days, on a 24 hourly basis, as per the CPCB guidelines. The sampling stations are located in Neyveli residential area around TPS I. Presently, suspended particulate matter (SPM), SO_2 and NO_x are being measured regularly using high volume air samplers. The measured values of these parameters have been found to be within the prescribed ambient air quality (AAQ) standards. Most of the measured SO_2 values (40-100%) are found to be in the range of 0-20 $\mu g/m^3$. As regards the SPM value, most of the observed values are between 50 to 150 $\mu g/m^3$.

Frequent measurements of carbon monoxide (CO) have revealed that the concentrations are within the prescribed limits. Respirable dust levels (concentration of dust particles which are smaller than 10 microns) in the mines are also being measured. The background levels of the SPM are relatively high but still within standards. This can be attributed to a number of other industrial activities in the area. Impact of the other industries on the air quality is described below.

4.7.2.2 Individual Emitters

(a) Lignite Mines I and II

Fugitive dust emissions are the main air pollution problem during various mining operations. The fugitive dust in the mines originates from overburden dumps, soil heaps, conveyor systems, excavation areas and movement of vehicles and machinery inside mines. NLC has taken preventative measures by planting tall trees around the mining areas and by adopting dust suppression measures such as water sprinkling at all the possible points of dust generation. Periodic surveys are conducted to assess the prevailing dust and noise levels inside mines.

(b) Thermal Power Plants I and II

In the thermal power plants, where lignite is fired for power generation, the main pollutants are suspended particulate matter (SPM), sulphur dioxide (SO_2), and, to a lesser extent, oxides of nitrogen (NO_x). The lignite used in the thermal power plants is low in sulphur (0.5 to 0.7%) and ash content (2.5 to 10%).

In the TPS I, commissioned about 25 years ago, mechanical precipitators, i.e. multiclones, have been provided for control of particulate emissions and have efficiency of the order of 80%. However, steps are being taken for installation of ESPs in all the units of TPS I in a phased manner. The newly constructed TPS II is provided with ESPs of 99% efficiency. These units also have high stacks (170 m and 225 m), thus dispersing the pollutants over longer distances thereby minimising the ground level concentrations (GLCs) in a major way.

(c) Fertiliser Plant

The Neyveli fertiliser plant producing urea is based on LSHS as feed stock and H_2S and original sulphur are major impurities. Here, H_2S and tail gas (CO, H_2, CH_4) are completely burnt along with air to produce SO_2 which is diluted sufficiently with air before its emission. NLC has plans for retrofitting the urea plant with modern technology not only for better capacity utilisation but also for energy conservation and to minimise air pollution due to ammonia emissions. The fine urea dust, discharged from the prilling tower is always well controlled and within the specified limits. The carbon dust from the gasifier is slurried, settled in pits and sold as fuel and thereby suspended carbon in the effluent is largely controlled.

(d) Briquetting and Carbonisation (B&C) Plant

In the B&C plant, raw lignite, with about 50% moisture, is dried to a 11-13% moisture content. After this, the required size reduction is achieved and the lignite is briquetted. The briquettes are then subjected to low temperature carbonisation to produce coke (trade name LECO) along with gas laden tar chemicals. This off-gas from the carbonisers is condensed and processed to yield tar chemicals.

In order to avoid air pollution due to lignite dust emission during lignite drying process, ESPs with a 99% capture efficiency for dust removal have been installed and the dust collected is recycled to the system. The steam evolved in the system is vented through a stack 30 m high. The fine lignite dust released from the conveyor network is dedusted by blowers and cyclone separators and the washings (carbon in water slurry) are settled in concrete pits from where the dry lignite dust is recovered and sold as fuel for kilns, furnaces, etc.

4.7.3 Baseline Air Quality Studies for the Proposed Plant

4.7.3.1 High-Volume Sampling Stations (8 hourly values)

The ambient air quality depends upon the emission sources and meteorological conditions. Baseline data is important in view of the fact that after superimposing the ground level concentrations (due to stack emissions from the proposed power plant) on the existing air quality, future ambient air quality can be predicted. This can then be compared with the specified ambient air quality (AAQ) standards and, in cases of violations, a suitable abatement plan could be designed.

AAQ monitoring was carried out at the following five stations. These monitoring stations are shown in Figure 4.4. The distances and directions of the monitoring locations with respect to the proposed plant are given below:

Monitoring Location	Direction W.R.T. Proposed Plant	Distance from Proposed Plant
Melakkuppam	North East	5
Umangalam	South West	3
Arasakuzhi	East and South East	26
Edakkuppam	West North West	3
Uthangal	Plant Site	0.5

The monitoring stations, Melakkuppam and Arasakuzhi are located on the leeward side of the predominant wind directions from the proposed site, i.e. south west (SW) and north east (NE) directions at a distance of 5 and 3 km respectively. The monitoring stations Umangalam and Edakkuppam are at cross wind directions, east south east (ESE) and west north west (WNW), at a distance of 2.5 and 3 kms, forming four equal sectors. The proposed site is very close to Uthangal village and hence the AAQ data collected at this station is supposed to be representative data for the baseline air quality at the proposed site. This monitoring location was about 0.5 km from the proposed site.

The AAQ monitoring was conducted (at each location) for three weeks with a frequency of two days per week, i.e. three samples of 8 hour durations each. However, at one location viz Uthangal, sampling was done only for a week, i.e. size no 8 hourly samples were collected.

The micro meteorological conditions at the proposed plant was assessed during the period of sampling. These meteorological conditions regulate the transport and diffusion of air pollutants into the atmosphere. The various parameters which have been considered were the wind speed, wind direction, relative humidity, rain fall and atmospheric pressure. The predominant wind pattern was towards the south west.

The maximum and minimum temperatures recorded during the sampling period were 34.8 and 25.1 degrees centigrade respectively. There was no rain fall during the period of sampling, except for a shower on 15th August 1993. The weather monitoring data was collected during the AAQ monitoring period and the results are shown in Table 4.6.

Details of the ambient air quality data collected during the three weeks period are given in Table 4.7. Summary of the data is given in Table 4.8. Average concentration of the pollutants collected during the three shifts (I, 0600-1400 hrs; II, 1400-2200 hrs; and III, 2200-0600) are also illustrated in Figure 4.5, 4.6 and 4.7. As shown in Figures 4.8 and 4.9, the 8 hourly values for particulates, sulphur dioxide and nitrogen dioxide are all below the ambient air quality limits set by the Ministry of Environment and Forests.

4.7.3.2 NO_2 Diffusion Tube Survey

In addition to the high volume sampling programme to obtain 8 hourly ambient air quality data, ambient air quality for nitrogen dioxide was also carried out using the diffusion tube method, a technique developed at Warren Spring Laboratory and Harwell Laboratory, UK.

The SO_2 diffusion tube technique was also employed but the results were found to be unreliable and therefore have not been presented in this report.

As shown in Figure 4.4, four monitoring sites were selected and these were:

- Arsaikuzhi	(site code F)
- Mudhani	(site code G)
- Card	(site code H)
- Umangalam	(site code I)

The tubes were mounted at least 5 cm away from the surface and in locations where air could freely circulate.

The NO_2 diffusion tubes were made of acrylic plastic with a triethanolamine impregnated stainless steel gauze located at the sealed end. In use, one end is removed, allowing for a measured exposure period. In the case of this survey, the sampling period was 15 days and the survey lasted for 4 months.

At the end of each sampling period, the open end is closed with a plastic cap and the tubes returned to AEA Technology, Oxfordshire, UK, for analysis. From this, an average 15 days NO_2 concentration is calculated and monthly averages for two consecutive sampling periods.

Results for August and September 1993 are shown in Table 4.9. Levels were between 8 $\mu g/m^3$ and 14 $\mu g/m^3$. The results agree with our 8 hourly values obtained from the higher volume sampling technique. If projected for the whole year, the values are well below the World bank annual ambient air quality standards for nitrogen dioxide.

4.8 EXISTING NOISE LEVELS

During an EPL visit to the area, continuous sound pressure levels (Leq) were measured at a number of locations within the proposed site boundary using a standard noise meter. The measuring locations are given in Figure 4.10 whilst the results are given in Table 4.10.

These measurements were taken when ambient conditions were unlikely to adversely affect results as wind speeds were approximately 2-3 m/s and no precipitation was falling.

The existing noise levels may used as a baseline against which future impacts can be assessed. For example, environmental noise criteria such as British Standard 4142 (1990) commonly recognise increases in existing levels as the most important factor in determining whether complaints may be expected. If the new Leq is 10 dB(A) above background noise complaints are considered likely whilst differences of 5 dB(A) are considered of marginal significance.

The current noise levels are relatively low and range from 39-54 dB(A). The major noise sources are ambient ones such as running water.

Table 4.1

Typical Wind Rose for Neyveli

Wind Direction	No. of day in the year	Percentage
E	45	12.3
NE	98	26
N	8	2.2
NW	4	1.1
W	18	4.9
SW	85	23.3
S	23	6.3
SE	70	19.2
CALM	14	3.8
TOTAL	365	100

Table 4.2

Typical Maximum / Minimum Temperatures for Neyveli

Month and Year	Maximum (°C)	Minimum (°C)
January	30.5	18.3
February	33.9	18.3
March	38.3	20.5
April	42.8	23.3
May	42.2	22.2
June	38.3	22.2
July	37.2	21.7
August	36.1	21.1
September	35.5	21.1
October	34.4	20
November	32.2	18.8
December	31.1	20

Table 4.3

Typical Analysis of the Tube Well Water

Parameter	Amount
Turbidity on silica scale (ppm)	Nil
pH value	6.25
P alkalinity (ppm $CaCO_3$)	Nil
M alkalinity (ppm $CaCO_3$)	37
Total hardness (ppm $CaCO_3$)	42
Calcium hardness (ppm $CaCO_3$)	28
Magnesium hardness (ppm $CaCO_3$)	14
Chloride (ppm Cl)	11.4
Total dissolved solids (ppm)	88.7
Silica SiO_2 (ppm)	87
Sulphate as SO_4 (ppm)	12.48
Dissolved CO_2 (as CO_2 ppm)	30.8

Table 4.4

Baseline Water Quality
(Concentrations in ppm unless indicated)

Constituents	Monitoring Stations							
	1	2	3	4	5	6	7	8
pH (@ room temperature (34°C))	7.8	7.11	8.39	7.84	7.04	6.94	7.05	6.7
Conductivity (us/cm @ 25°C)	759	76	62	509	344	213	342	160
Free CO_2	6	5.6	Nil	3.4	20	30	25	31
Bicarbonate alkalinity as $CaCO_3$	82	17	6	86	106	72	138	40
Carbonate alkalinity as $CaCO_3$	Nil	Nil	36	Nil	Nil	Nil	Nil	Nil
Hydroxide alkalinity as $CaCO_3$	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Total Hardness as $CaCO_3$	250	20	38	146	74	84	132	60
Temporary Hardness as $CaCO_3$	82	17	38	86	74	72	132	40
Permanent Hardness as $CaCO_3$	168	3	Nil	60	Nil	12	Nil	20
Chloride as Cl	9.5	3	8	53	38	8	13	8
Calcium as Ca	73.6	4	13.6	34.4	16	23.2	32	14.4
Magnesium as Mg	16.04	2.43	0.99	14.58	8.26	6.32	12.64	5.83
Silica as SiO_2	36.4	839	543.8	194.8	1162.6	198	51.2	146.2
Iron and Aliminium oxide as R_2O_3	7.6	148	116.6	33	164.4	4	6.6	25.4
Sulphate as SO_4	217.35	12.35	6.75	58.56	18.44	8.15	15.14	8.72
Sodium and Potassium in terms of Na	27.69	6.49	21.3	30.12	48.24	3.64	9.85	0.21
Iron as Fe	0.18	10	9	4	20	0.3	0.18	0.18
Total solids	519	1029	781	610	1784	347	249	224
Dissolved solids	480	902	622	410	1304	212	220	206
Suspended solids	39	127	159	200	480	135	29	16

Table 4.5

Effluent Water Quality
(Concentrations in ppm unless indicated)

Constituents	Source 1	Source 2	TNPCB Tolerance Limits
pH @ room temp. (34°C)	8.49	8.46	5.5 to 9
Particle size of total suspended solids	Passes 850um IS sieve	Passes 850um IS sieve	Shall pass 850um IS sieve
Total solids	925	927	-
Dissolved solids	910	908	2100
Suspended solids	15	19	100
Dissolved Oxygen	6.8	6.49	-
Biological Oxygen Demand (5 days at 20°C)	3.6	2.5	30
Chemical Oxygen Demand	52.04	58.55	250
Oil and Grease	Nil	Nil	10
Total nitrogen as N	2.8	2.24	100
Ammonical nitrogen as N	Nil	Nil	50
Organic nitrogen as N	2.8	2.24	-
Free ammonia as NH_3	Nil	Nil	5
Phopsphates as P	0.08	0.1	5
Phenolic compounds	Nil	Nil	1
Cyanides as CN	Nil	Nil	0.2
Sulphides as S	Nil	Nil	2
Sulphates as SO_4	395.7	392.41	1000
Total residual chlorine	Nil	Nil	1
Fluorides as F	0.73	0.79	2
Chlorides as Cl	120.6	106.4	1000
Calcium as Ca	131.2	116.8	-
Magnesium as Mg	35.48	31.1	-
Potassium as K	2.08	2.02	-
Sodium as Na	97.70	95.3	-
Sodium (%)	30.86	32.94	-
Residual sodium carbonate (epm)	Nil	Nil	-
Arsenic as As	Nil	Nil	0.2
Hexavalent Chromium as Cr	Nil	Nil	0.1

Notes: -

Source 1 - Thermal Station II, Stage I, Ash bund overflow
Source 2 - Thermal Station II, Stage II, Ash bund overflow

Table 4.6

Weather data for the month of August 1993

Date	Rainfall (mm)	Evaporation (mm)	Max. Temp. (°C)	Min. Temp. (°C)	Rel. Hum. (%) 0830hr	Rel. Hum. (%) 1430hr	Barom. Press. (mm) 0830hr	Barom. Press. (mm) 1430hr	Barom. Press. (mm) 1730hr	Wind Speed km/hr 0830	Wind dir.	Wind Speed km/hr 1430	Wind dir.
1/8/93	0	4	34.4	26.7	73	49	755.04	752.1	751.59	2.4	SW	3.8	SW
2/8/93	0	4.6	34.4	26.1	69	47	754.96	752.42	752.1	3.2	SSW	2.5	SSW
3/8/93	0	4.4	35.6	25.6	66	43	755.12	752.33	752.17	4	ESE	2.2	NNW
4/8/93	0	5.3	36.7	25.6	60	48	755.04	752.93	752.26	4.7	SSW	4.5	NW
5/8/93	0	3.8	36.1	25.6	73	51	756.06	754.64	753.69	3	SW	3.4	SW
6/8/93	2	5	34.4	24.4	80	56	758.77	756.82	756.67	3.5	NNE	7.2	SSE
7/8/93	0	2.7	33.9	26.1	73	49	759.72	756.67	755.47	3.3	SW	2.5	S
8/8/93	0	5.3	35	23	87	56	759.72	755.63	755.24	0	C	3.2	SSW
9/8/93	5	2.5	33.3	23.3	84	62	757.73	755.29	754.45	3.8	SSW	3.3	SW
10/8/93	12.4	3.1	33.3	24.4	76	53	756.74	754.89	755.14	3	SW	3.2	SSW
11/8/93	0	3.4	33.3	25	73	54	758.34	755.91	753.8	9	SWW	1.8	WSW
12/8/93	0	3.3	32.2	24.4	73	51	757.5	754.36	753.94	2.5	SW	8.6	W
13/8/93	0	3.6	35	24.4	76	49	756.82	753.26	753.94	10.8	W	10.4	SW
14/8/93	1	3.8	35	25.6	76	49	756.56	754.2	753.94	10.8	W	3.4	WSW
15/8/93	5.6	3.2	34.4	25.6	65	46	756.99	754.45	753.94	9.7	SW	21.6	SW
16/8/93	0.6	2.6	34.7	25.6	73	46	757.07	754.45	753.85	8.4	SW	6.8	SSW
17/8/93	0	2.6	35.6	25.6	66	39	757.18	754.71	753.77	3.2	SW	2.6	SW
18/8/93	0	6.8	36.1	25.6	77	49	757.43	755.14	754.53	2.8	SW	0	C
19/8/93	0	4	35	25.6	73	49	757.5	754.89	753.77	2.7	SW	14	SE
20/8/93	0	5.2	35	25.6	70	45	757.43	754.13	753.26	11.5	SW	11.9	SW
21/8/93	0	5.2	36.1	25	63	38	756.74	753.11	752.67	4.8	SW	21.6	SSW
22/8/93	0	5.2	36.7	25.6	66	39	756.06	752.86	752.33	9.7	SW	7.2	NE
23/8/93	0	5.1	37.2	27.8	66	45	756.74	754.02	753.94	21.6	SW	9.4	W
24/8/93	0	4.3	36.1	25.6	63	39	756.92	753.94	753.85	9.7	W	11.2	SW
25/8/93	8	4.1	36.7	23.3	73	46	757.66	754.71	755.47	1	SW	2.2	WSW
26/8/93	1.4	2.9	35	24.4	84	50	757.75	754.71	754.28	0	C	13.3	SW
27/8/93	0	4.5	33.3	24.4	80	58	756.41	753.52	753.62	2.5	WSW	10.1	SW
28/8/93	0	2.7	32.2	24.4	80	54	756.23	753.37	756.37	5.4	SSW	11.5	SW
29/8/93	2.6	2.5	34.4	24.4	84	49	756.16	753.34	752.67	2.5	SW	3.2	SW
30/8/93	0	4.8	33.9	25	80	54	756.06	752.75	752.42	10.4	SW	3.2	N
31/8/93	33.5	7.1	35	23.3	87	65	755.8	753.44	753.44	0	C	3.6	SW

Table 4.7

Ambient Air Quality (AAQ) Analysis

Monitoring Location: Melakkuppam

Parameter	Mean Concentration (in ug/Nm^3)		
	I	II	III
Suspended Particulate Matter	45.9 (13.6)	30.1 (71.8)	31.7 (13.2)
Sulphur Dioxide	2.4 (2.08)	4.3 (6.4)	2.2 (2.1)
Oxides of Nitrogen	8.6 (1.9)	6.8 (3.1)	16.8 (24.8)

Monitoring Location: Edakkuppam

Parameter	Mean Concentration (in ug/Nm^3)		
	I	II	III
Suspended Particulate Matter	39.3 (13.9)	58.9 (28.1)	25.5 (8.1)
Sulphur Dioxide	0.5 (0.5)	2.8 (2.7)	2.8 (3.2)
Oxides of Nitrogen	10.1 (6.1)	13.3 (7.8)	12.8 (3.7)

Monitoring Location: Umangalam

Parameter	Mean Concentration (in ug/Nm^3)		
	I	II	III
Suspended Particulate Matter	25.4 (9.9)	51 (24.1)	20.9 (6.4)
Sulphur Dioxide	1.3 (1.3)	3.8 (4.0)	1 (0.5)
Oxides of Nitrogen	9.5 (5.7)	17.6 (7.8)	12.2 (6.3)

Monitoring Location: Uthangal

Parameter	Mean Concentration (in ug/Nm^3)		
	I	II	III
Suspended Particulate Matter	39.3 (13.9)	58.9 (28.1)	25.5 (8.1)
Sulphur Dioxide	0.5 (0.5)	2.8 (2.7)	2.8 (3.2)
Oxides of Nitrogen	10.1 (6.1)	13.3 (7.8)	12.8 (3.7)

Monitoring Location: Arasakuzhi

Parameter	Mean Concentration (in ug/Nm^3)		
	I	II	III
Suspended Particulate Matter	50.4 (11.9)	73.2 (15.3)	30.1 (9.8)
Sulphur Dioxide	1.5 (1.3)	2.2 (1.3)	1.5 (1.6)
Oxides of Nitrogen	7.6 (3.5)	6 (2.6)	6.6 (4.4)

* Figures in brackets indicate standard deviation

Table 4.8

Maximum, minimum and mean concentrations of AAQ parameters

Sampling Location	SPM (ug/m^3)			SO$_2$(ug/m^3)			NOx(ug/m^3)		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Melakuppam	102	9.2	19.8	17.2	0.2	4.6	66.2	3.4	11.6
Umangalam	80.6	17.7	32.4	11.4	0.2	3.4	19.3	3.5	13.1
Arasakuzhi	87.6	20.9	51.2	4.6	0.6	2.4	13.5	1.5	7.7
Edakkupam	96.8	13.8	41.2	8	0.1	3.7	25.2	2.8	12.1
Uthangal	70.5	27.3	48.8	4.9	0.4	2.6	19	3.7	9.5

Table 4.9

Nitrogen Dioxide Survey (ug/m^3)

Survey Period	Site Name (and reference)			
	Arasakuzhi (F)	Mudhani (G)	Card (H)	Umangalam (I)
12/08/93–27/08/93	8.2	10.25	10.25	–
21/08/93–05/09/93	–	–	–	8.2
27/08/93–10/09/93	–	–	8.2	–
27/08/93–11/09/93	6.15	10.25	–	–
05/09/93–21/09/93	–	–	–	10.25
10/09/93–25/09/93	–	–	10.25	–
11/09/93–25/09/93	10.25	14.35	–	–
25/09/93–09/10/93	TBA	TBA	TBA	TBA
09/10/93–23/10/93	TBA	TBA	TBA	TBA
23/10/93–06/11/93	TBA	TBA	TBA	TBA
06/11/93–20/11/93	TBA	TBA	TBA	TBA
20/11/93–06/12/93	TBA	TBA	TBA	TBA
06/12/93–22/12/93	TFM	TBA	–	TBA
AVERAGE	8.2	11.6	9.6	9.2

Notes:–

(–) due to monitoring over different periods at different sites

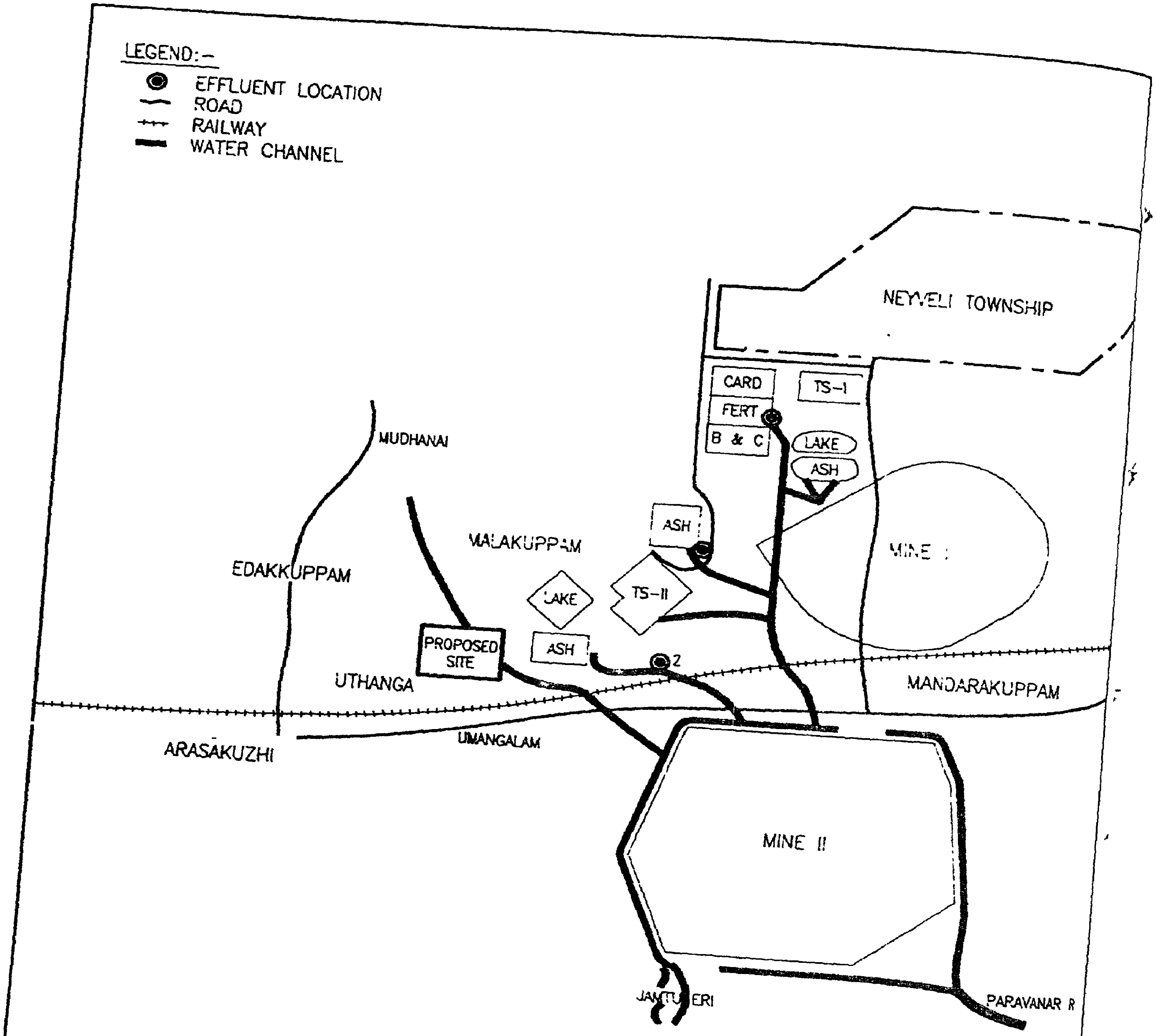
TBA – To Be Advised

TFM – Tube Found Missing

Table 4.10

AMBIENT NOISE MEASUREMENTS IN VICINITY OF PROPOSED SITE

Measuring Point	Site Description	Value	Notes
A	North west corner of proposed ash dump	43	None
B	Western perimeter of ash dump for TPS 11	52	Stream in close proximity to measuring location
C	Equi–distant between proposed ash dump and TPS II ash dump	44	None
D	Eastern perimeter of propsed ash dump	40	None
E	Within southern boundary of proposed ash dump	46	None
F	Southern shore of lake in close proximity to TPS II	47	Stream in close proximity to measuring location
G	Eastern shore of lake in close proximity to TPS II	46	Noise from TPS II evident in background
H	Northern shore of lake in close proximity to TPS II	47	Residential area with human activities adding to back ground levels
I	In close proximity to both the future ash dump and Vridhachalam Kuddalore road	44	Residential area with human activities adding to back ground levels
J	South of Vridichalam – Kuddalore road	45	Relatively infrequent passage of trains and none encountered during measuring period



EFFLUENT SAMPLES:-
1 TS-I, STAGE-I, ASHPOND OVERFLOW
2 TS-II, STAGE-II, ASHPOND OVERFLOW

MAP SHOWING HYDROLOGY AND DRAINAGE OF AREA

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EWBANK PREECE

FIG. 4.1

Cl/HCO_3+CO_3 RATIO OF THE TUBEWELLS ALONG THE COASTAL BELT

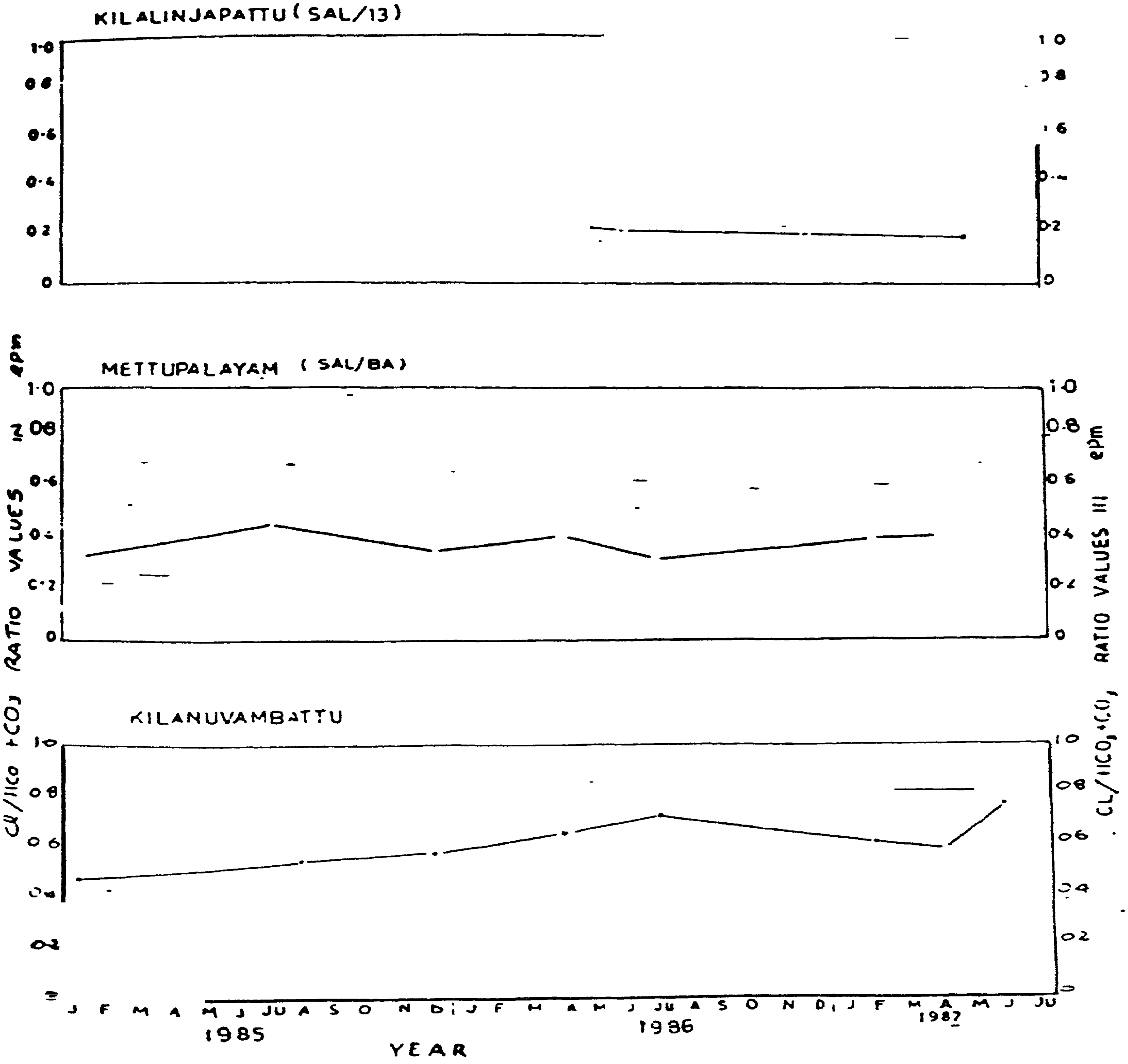
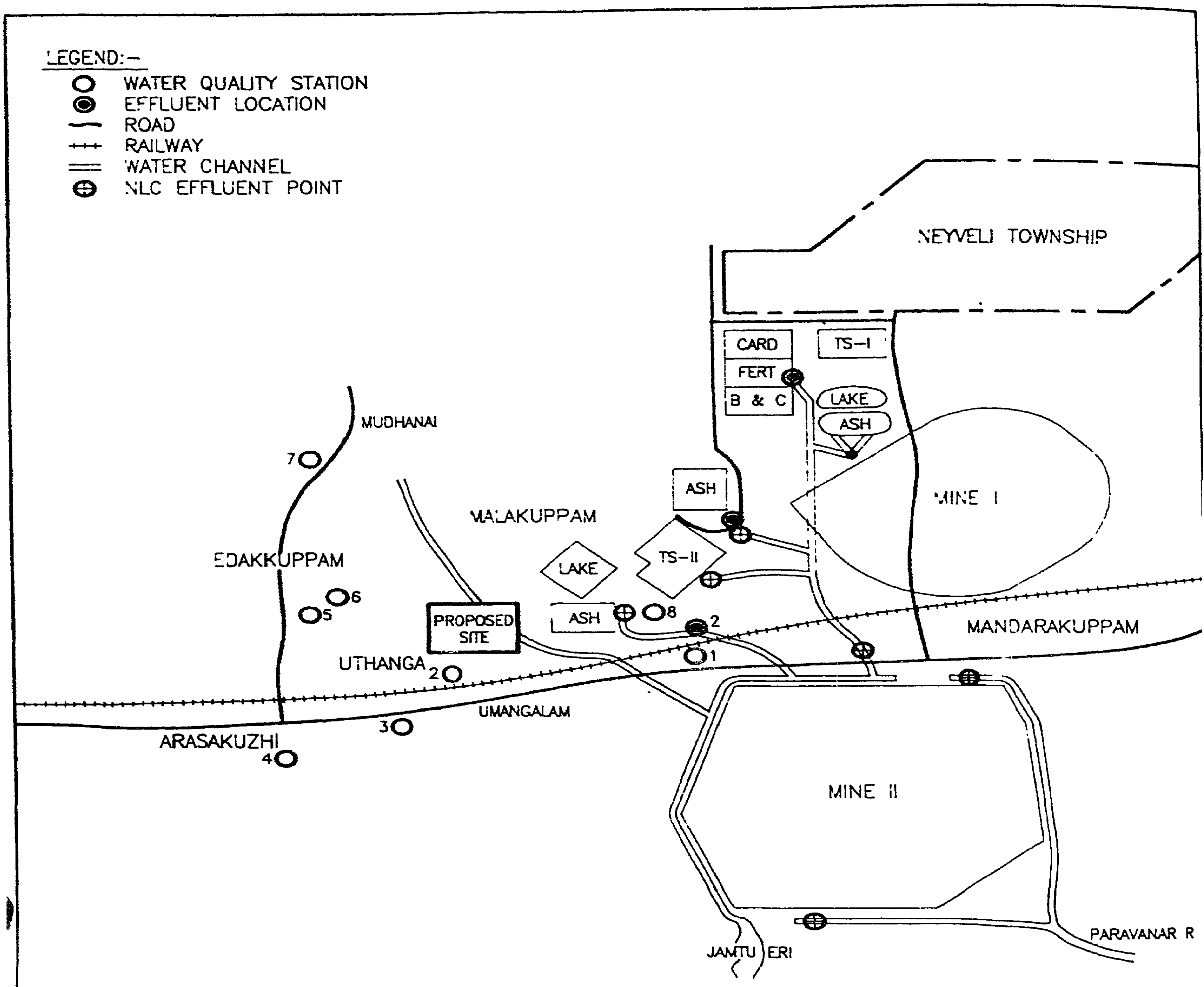


FIGURE 4.2



EFFLUENT SAMPLES.–

1 TS–I, STAGE–I, ASHPOND OVERFLOW
2 TS–II, STAGE–II, ASHPOND OVERFLOW

WATER SAMPLE POINTS.–

1 PERENIAL POND, UMANGALAM
2 SEASONAL POND, UTHANGAL
3 BOREWELL, UAKARAM
4 BOREWELL, ARASAKUZHI
5 PERENIAL POND, UAKARAM
6 BOREWELL, KAMAPURAM
7 PERENIAL POND, VRITHAKIRIKUPPAM
8 PERENIAL POND, KUNANKURICHI

WATER SAMPLING STATIONS

EWBANK PREECE

FIG. 4.3

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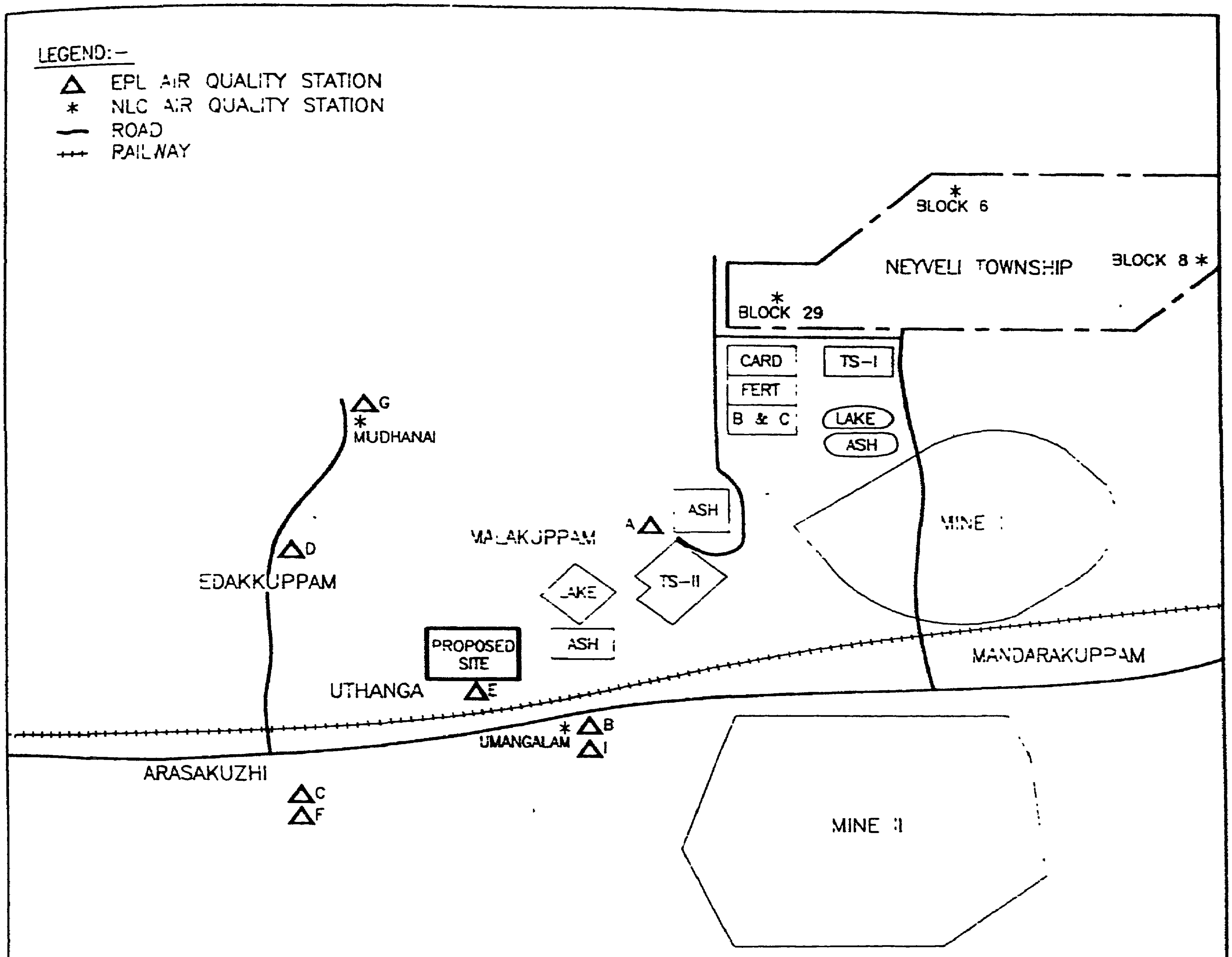

AIR QUALITY STATIONS:-
(8 HOUR SAMPLES)

A	MELAKKUPPAM
B	UMANGALAM
C	ARASAKUZHI
D	EDAKKUPPAM
E	UTHANGAL

AIR QUALITY STATIONS:-
(15 DAY SAMPLES)

F	ARASAKUZHI
G	MUDHANAI
H	CARD
I	UMANGALAM

AIR QUALITY SAMPLING STATIONS

EWBANK PREECE

FIG. 4.4

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Ambient Air Quality Status

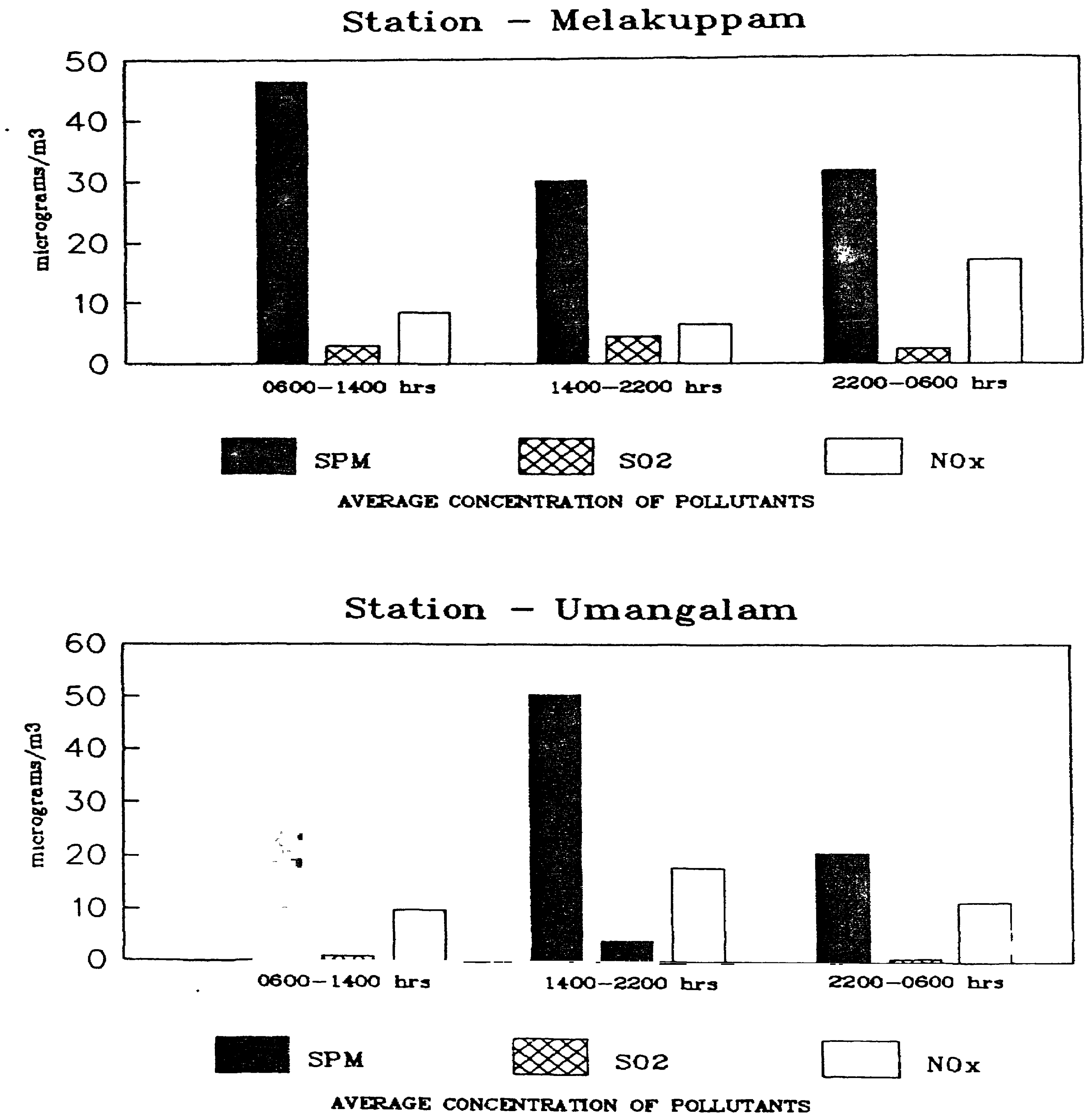
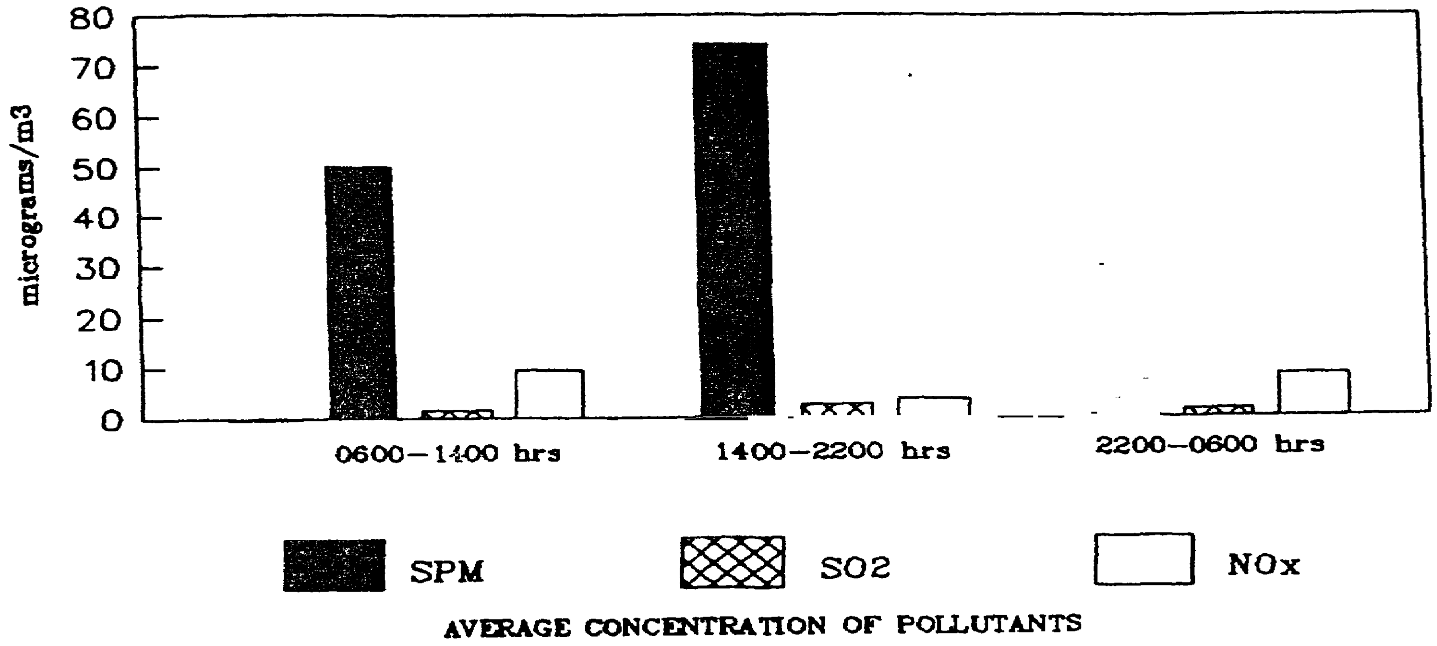


FIGURE 4.5

Ambient Air Quality Status

Station – Arasakuzhi



Station – Edakuppam

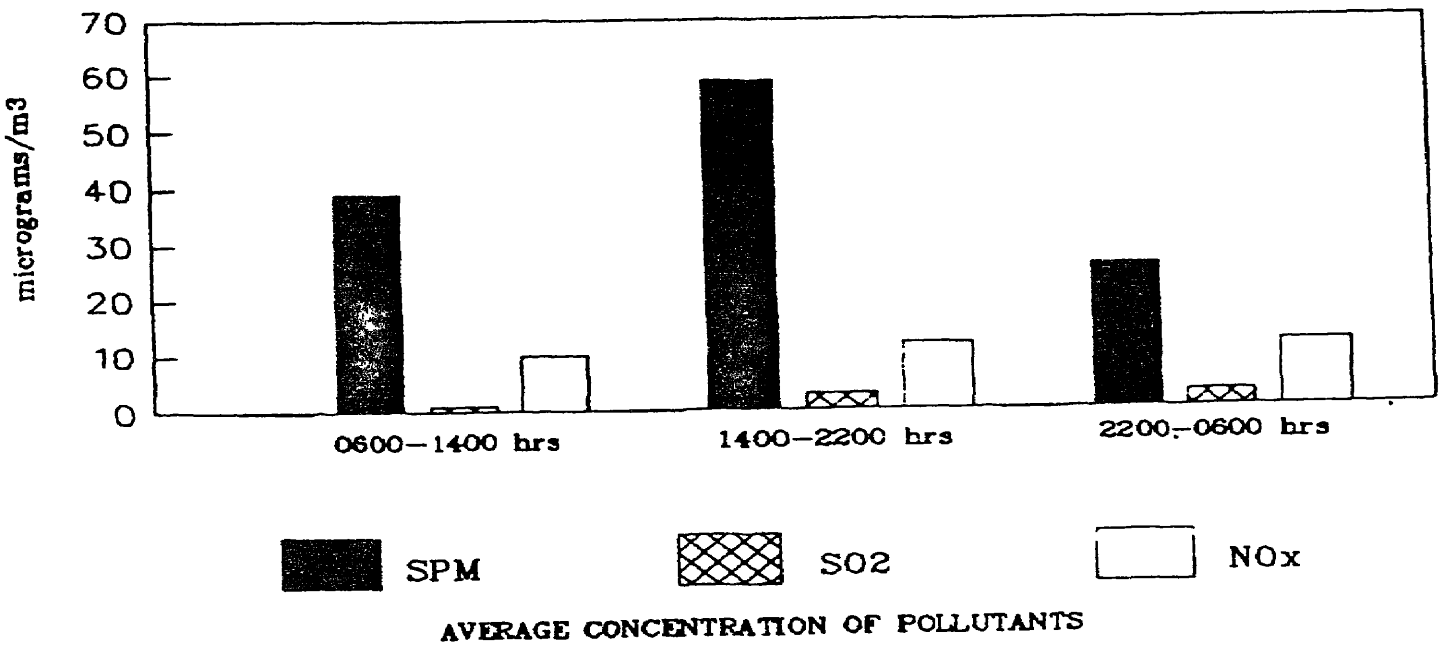


FIGURE 4.6

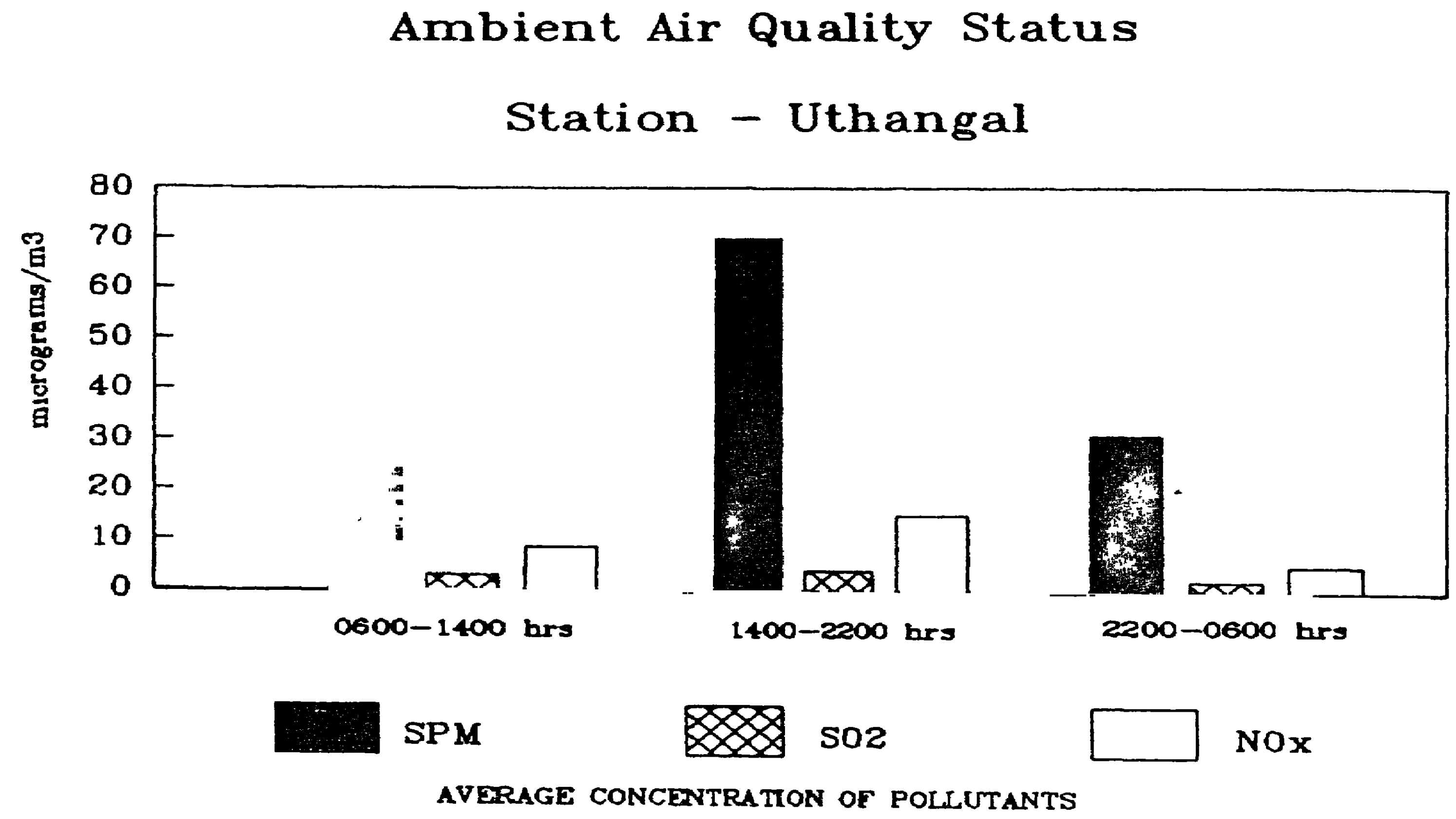
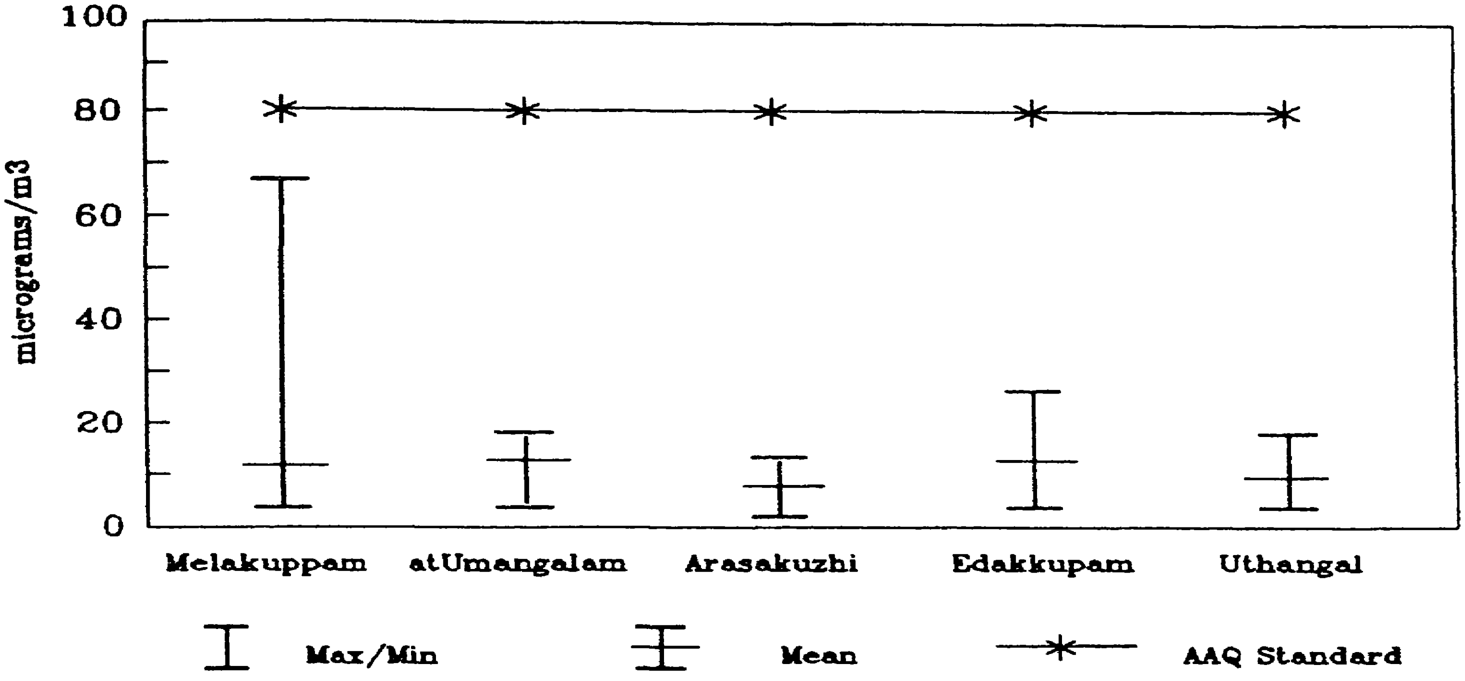
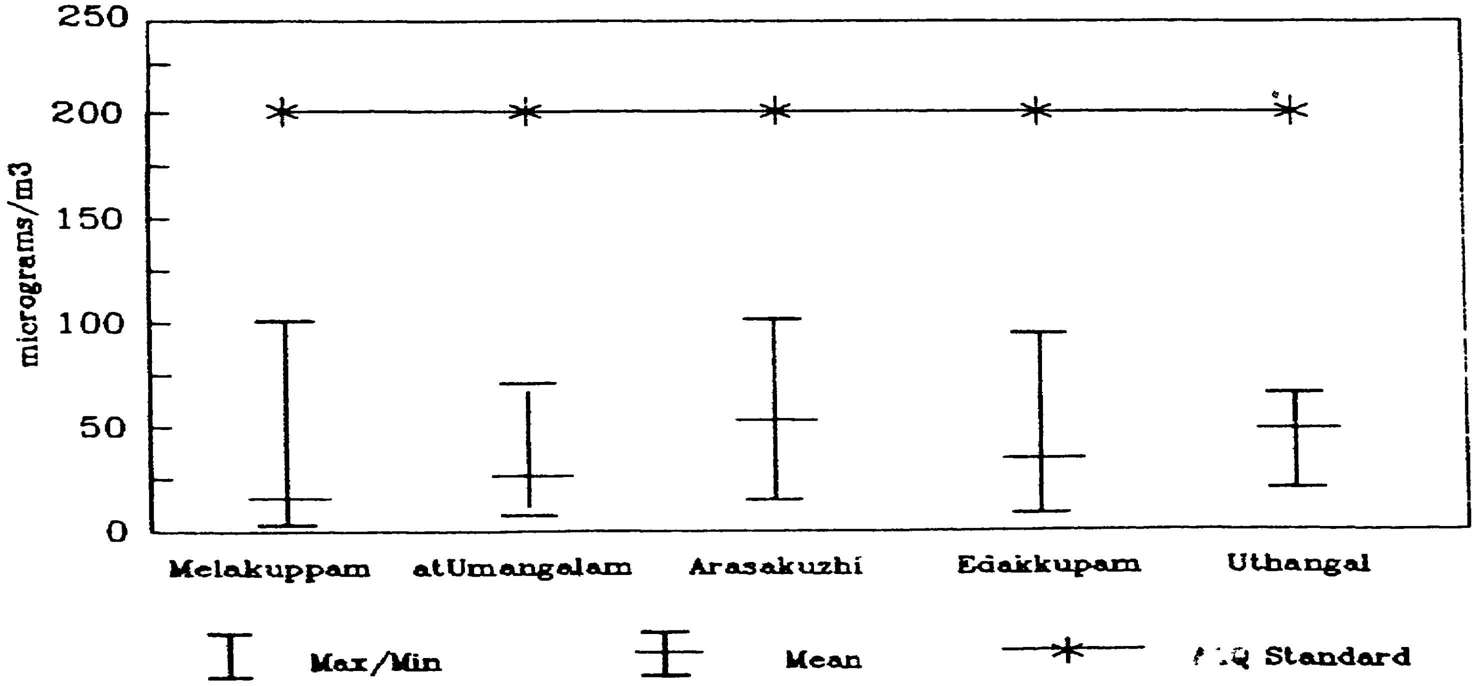

Ambient Air Quality Status
Station - Uthangal
micrograms/m3
80
70
60
50
40
30
20
10
0
0600-1400 hrs
1400-2200 hrs
2200-0600 hrs
SPM
SO2
NOx
AVERAGE CONCENTRATION OF POLLUTANTS

FIGURE 4.7



Ambient Air Quality (NOx)
Neyveli TPS - Zero unit



Ambient Air Quality (SPM)
Neyveli TPS - Zero unit

FIGURE 4.8

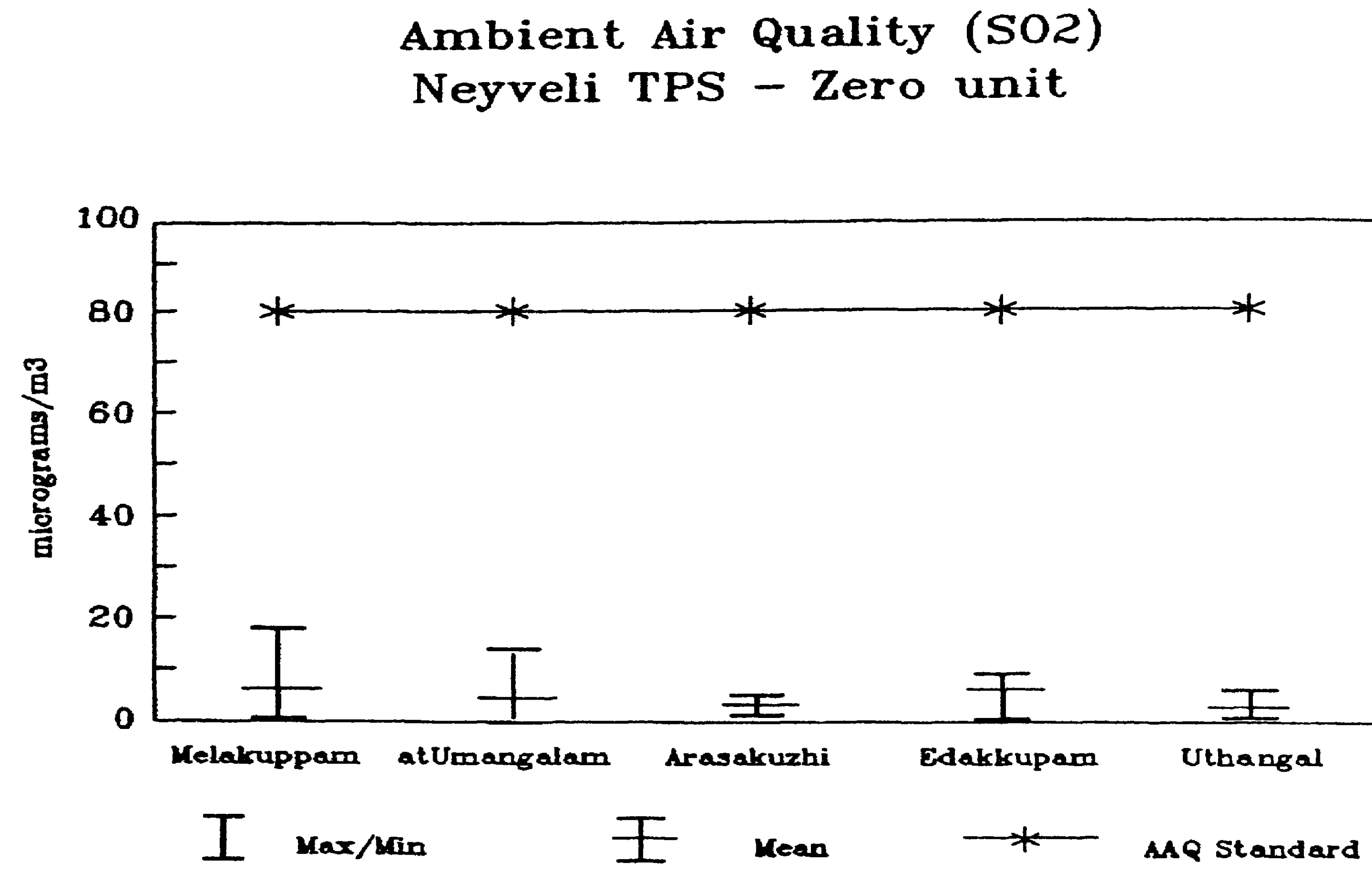
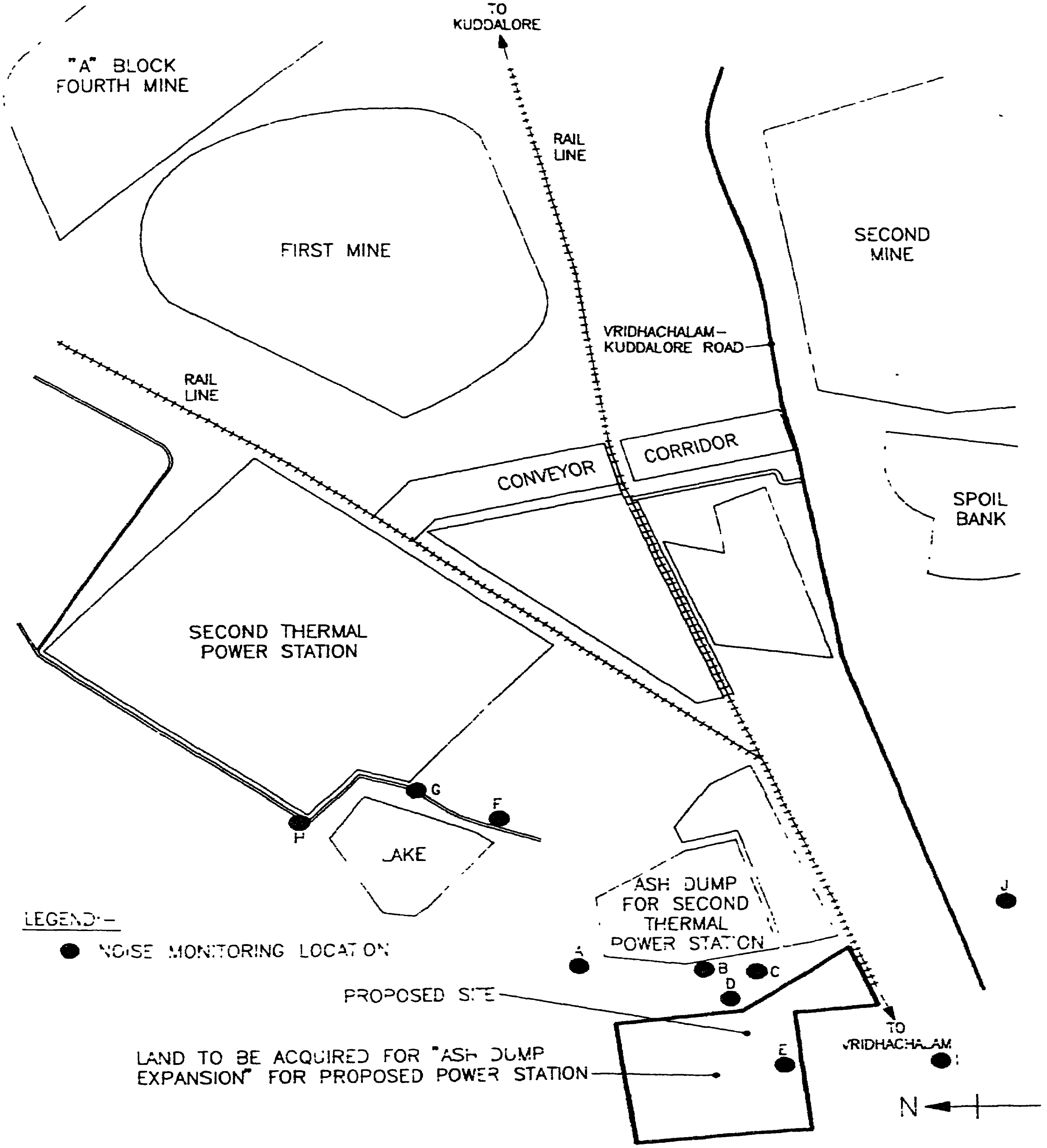

Ambient Air Quality (SO2)
Neyveli TPS - Zero unit
100
80
60
40
20
0
micrograms/m3
Melakuppam
atUmangalam
Arasakuzhi
Edakkupam
Uthangal
Max/Min
Mean
AAQ Standard

FIGURE 4.9


TO KUDDALORE
"A" BLOCK FOURTH MINE
RAIL LINE
FIRST MINE
SECOND MINE
VRIDHACHALAM–KUDDALORE ROAD
RAIL LINE
CONVEYOR CORRIDOR
SPOIL BANK
SECOND THERMAL POWER STATION
G
F
H
LAKE
ASH DUMP FOR SECOND THERMAL POWER STATION
J
LEGEND:-
● NOISE MONITORING LOCATION
A
B
C
D
PROPOSED SITE
TO VRIDHACHALAM
E
I
LAND TO BE ACQUIRED FOR "ASH DUMP EXPANSION" FOR PROPOSED POWER STATION
N

NOISE MONITORING LOCATIONS IN RELATION TO THE SITE

96402

EWBANK PREECE

FIG. 4.10

DRAWN BY AUTOCAD

SECTION 5

EXISTING ENVIRONMENT - ECOLOGICAL

SECTION 5

EXISTING ENVIRONMENT - ECOLOGICAL

5.1 BACKGROUND

The climate of an area has a direct relationship with the type of biological environment it can sustain. The climate in the Neyveli region is xerothermic tropical with a dry period of 5 to 6 months a year. Temperature varies from 15.6°C to 42.8°C (as per the meteorological data of the last 10 years). The rainfall (data over 30 years) varies from 576 mm to 1700 mm annually with an average humidity of 60% varying from 20 to 100%. Evaporation rates are also higher with an average of 3.5 mm per day.

An extensive field survey was undertaken for the assessment of existing biological environment with the objective of identification of flora and fauna species that exist in the region. An area of approximately 30 km radius from the proposed power plant site was surveyed. A quick sampling of the flora including herbs, shrubs, trees and lianas was done in all the four directions from the proposed site.

In addition, visits were also made to rivers and ponds in and around the core and buffer zones of the proposed unit where a survey of aquatic flora and fauna was undertaken. A survey was also conducted to identify avian and mammalian species existing in the region. Information was also collected from the State Forest Departments as well as earlier reports on the same subject.

5.2 TERRESTRIAL AND AQUATIC FLORA

Neyveli was once covered with various types of forests namely, moist tropical forests, dry tropical forests, deciduous forests, tropical dry evergreen forests, scrub thorny forests and mangroves or tidal swamps. The type of forests and their floristics has been given in Cuddalore forest division working plan (from 1966 to 1976).

In addition to these forests, this division also has riverine forests which are along the Manimuktha river and the Vellar river. These rivers are seasonal and carry very small discharges even during monsoons. The proposed power plant will be situated in close proximity to the existing Thermal power station

II, and also close to a reserve forest once called Ammeri Reserve Forest which is within the core zone of the proposed thermal power station. This forest, which is less than 1 km from the proposed site, contains a small number of shrubs and is mainly an open land. A total of 1154 plant species including herbs, shrubs, trees and lianas have been identified in Cuddalore South Division (which includes Cuddalore, Chidambaram and Viruddhachalam taluks in South Arcot district) working plan. This was based on a survey conducted by the Forest Department during 1965-66.

However, practically no reserve forests exist in an area of 30 km radius of the proposed site as of today. All the reserve forests, as per the 1953 Survey of India topo sheets, have been converted to either cashew plantations or agricultural lands. Most of the reserve forests of Viruddhachalam range dereserved and handed over to NLC. There however, exists a patch of about 25 ha having acacia nilotica forests. This is about 30-35 km away from the proposed site (spatially) and about 5 km away from Viruddhachalam towards Ulundurpet.

During a survey, conducted over a period of three days in Viruddhachalam range, about 62 species of plants were identified and listed. Only 5.4% of the plants are represented today as compared to the 1950s census. Although the survey was only conducted in a part of the Cuddalore working division, the habitats in the other parts are very similar and diversity within such a short geographical area would not vary much.

There is a substantial reduction in the floral diversity in comparison to that among birds and mammals. This may be primarily due to versatility with which animals change their habitats unlike sedentary plants. This reduction in floral diversity may be due to the increasing population pressure and various developmental activities that have been present in the area for the last thirty years.

As far as the impact on the biological environment is concerned, the impact of developmental activities such as lignite mining, thermal power stations, etc, could be for very large areas due to particulate emissions, fly ash disposal, thermal pollution, etc. However, in all the existing units, adequate attention has been given to preservation of ecology and necessary care has been taken for environmental management.

The efforts of the NLC in afforestation programmes are commendable, and they also obtained the prestigious Indira Priyadarshini Vrikshamitra Award, instituted by the Ministry of Environment and Forests, Government of India, for the year 1988 for their excellence in afforestation programmes. Practically, the NLC township bears a better look with trees than are the reserve forests themselves. NLC has planted fast growing species such as eucalyptus and acacia aruculiformis in the spoil banks.

The list of flora in the core and buffer zones is given in Appendix D.

5.3 TERRESTRIAL AND AQUATIC FAUNA

As per the Cuddalore south division working plan, there were about 39 species of mammals and reptiles, and about 132 species of birds. In a three day survey conducted i the Viruddhachalam range, about 34 species of birds and 14 species of mammals and reptiles are represented today as compared to 1950s census. The avifauna in this region is much more varied than the terrestrial fauna. The presence of numerous irrigation tanks and back waters provided suitable refuge for the birds. The list of fauna (including birds) in the core and buffer zones is given in Appendix E.

5.4 SUMMARY

The following activities may directly or indirectly affect the ecological setting in a region:

- Human activities
- Noise levels
- Land degradation
- Deforestation

In this case, only the first two activities may have some impact on the ecological setting. However, there is extensive human activity in the region even without this project. This is primarily due to a number of other industrial activities in the area. Most of the flora that now exists in the area is due to the efforts under the afforestation programme of the NLC. The construction of the proposed plant will, therefore, not have any significant impact on the flora and fauna. The animal species identified in the area seem to have adapted themselves to the surrounding environment and hence would be least affected. As far as the floral species are concerned, there is no endangered or rare flora species in proximity of the proposed plant. The most important aspect is that the flora and fauna which are represented here in this site are also represented elsewhere in the state and in the country, hence there is no danger of damage to the biological environment.

SECTION 6

EXISTING ENVIRONMENT - SOCIAL AND ECONOMIC

SECTION 6

EXISTING ENVIRONMENT - SOCIAL AND ECONOMIC

6.1 POPULATION AND COMMUNITIES

Neyveli town can be described as a relatively large residential area' closely associated with the mining industry, power generation, the fertiliser plant and attendant service industries.

The township has a population of approximately 350 000 of which almost 250 000 are employed by the Neyveli Lignite Corporation. The remainder consist of people of pre or post employment age, those looking for employment or those engaged in service industries.

The population is predominantly of Tamil Nadu origin with its approximate religious composition being as follows:

- Hindu 90%
- Moslem 5%
- Christian 5%

In addition to being the main employer the NLC is also responsible for many other services within the area. For instance, it is the major landlord and the quality of housing is generally good reflecting the position of the occupant within the company. Despite the presence of three police stations the investigation of petty crimes is normally the responsibility of NLC's in-house security force and involvement of state police is only regarded as a last resort.

The local political atmosphere is closely linked with the seven large unions representing the workers of this area. The largest of these is the Direavida Mvennetrea Kataheam (DMK) which has a strong affiliation with the local state party. The township has one member on the states legislative Assembly and this individual is known as a Member of the Legislative Assembly (MLA). Neyveli township is part of the Chidheajumharaim district in terms of selecting a member of parliament (MP) to represent local interests at the central Government in Delhi.

6.2 EDUCATION AND EMPLOYMENT

6.2.1 Schooling

Compulsory schooling begins at the age of six and a number of local schools exist for educating children until the age of 16. These schools also cater for children coming from villages outside of the immediate Neyveli township area.

Further education after the age of 16 is provided by one of two colleges and this is supplemented by training for NLC and neighbouring state electricity board employees in their own training centres. The nearest university and institute of technology are at Madras.

6.2.2 Employment

The 250 000 people employed by the NLC work in the following areas:

- the mining operations at Mine I and II
- the thermal plants TPS I and TPS II
- the fertiliser plant
- the clay washing plant
- support and auxiliary service associated with the above.

Other forms of employment not directly related to NLC include the following:

- educational services
- local retailers and merchants
- agriculture.

6.3 HEALTH

The general health of local inhabitants and employees is less than ideal despite sufficient numbers of doctors and medical staff and availability of hospital facilities. This is mainly attributable to the degraded local environment and inadequate infrastructure. It is also compounded by the presence of open sewers, public ignorance of personal hygiene, lack of sanitary facilities and poor waste management procedures.

The area is characterised by lack of modern dentistry although this is mainly due to the absence of demand for such services. Responsibility for payment of medical and dentistry bills lies with the individual and no provisions for health care insurance are provided by local authorities or the NLC.

6.4 LAND USE AND LAND USE PLANNING

The land usage within the industrial complex can be categorised into the following:

- Built-up/residential areas
- Mining
- Industrial interests
- Agriculture
- Natural or semi natural vegetation

In terms of geographical area covered and overall appearance, the area is dominated by NLC's mining operations and agriculture now accounts for only 10% of land usage within a 25 km radius. This predominance of mining activities is reflected in the corporation's land use planning strategy which aims to convert mining areas back to their original state or to improve on the pre-mining condition. This initiative has had only limited success and the degraded soil associated with reclaimed land makes large tracts unsuitable for agriculture.

6.5 INDUSTRY AND MINING

The Neyveli township's large residential complex is totally dependent upon the mining, power generation and industrial activities which take place there. The main existing activities are:

a) Mining - development and operation of Mine I

b) Development and operation of Mine II

c) Fertiliser production

d) Clay washing plant.

These four different operations dominate industrial activities of Neyveli and almost 250 000 people are employed in their operation.

6.6 AGRICULTURE

Agriculture at Neyveli is at a relatively low level of activity and the following crops are all grown in small quantities:

- rice
- sugar cane
- cashew nuts
- market vegetables

The quantities produced are grossly insufficient to supply Neyveli's demand and additional foodstuffs are transported by road from other areas. A number of small farms practice limited animal husbandry for the production of mile or meat. Animals kept include cattle, goats, pigs and poultry. The degree of mechanism on such farms is relatively basic.

6.7 TOURISM

NLC has a Public Relations Department to cater for tourism and all other visiting groups.

However, tourists for site seeing are rare as there are few attractions to interest visitors. Visitors coming to the area from outside include relatives and associates of employees and organisational representatives supplying equipment or consultancy services to NLC. In addition, the sites industrial nature attracts schools or college parties associated with educational tours.

6.8 TRANSPORT

Neyveli is well served by both road and rail infrastructure with the latter generally being of good standard and well maintained. The roads accommodate a mixture of public, private and freight transport although lorries transporting heavy goods have been diverted from the township via access roads to the mine and power plants.

Railway line links Neyveli to all other major towns in Tamil Nadu and these accommodate passengers as well as lignite destined for distant cement works. The frequency of service is currently 3-4 trains per day and scope exists for further expansion of public service and freight transportation.

6.9 ARCHEOLOGICAL AND HISTORICAL SITES

There are a number of historical and cultural sites within a 25 km radius and the more mentioned ones include the following:

a) A Roman Catholic church at Neyveli township approximately 9 km from the proposed site.

b) The Samadhi of Sri Ramalinga Swamy at Vladur, 13 km from the TPS II.

c) A Vishanhue temple at Srimusham, 19 km from Power Station II.

d) A Savite temple at Vrichachalam, 13.5 km from Power Station II.

However, there are no sites or archeological interest within a 25 km radius of Neyveli township.

6.10 OTHER CURRENT OR PROPOSED DEVELOPMENT PROJECTS

In addition to the current proposed development the 250 MW unit generation plants have been formulated by the Central Electricity Authority, Industry of Power for additional units to be installed by the year 2005. This would involve development of Mines III and IV.

We are not aware of any other industrial growth proposed in the meantime although it is possible that other industrial units may follow as a result of the availability of additional power in the area.

SECTION 7

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES DURING CONSTRUCTION

SECTION 7

CONSTRUCTION IMPACTS AND MITIGATION MEASURES

OVERVIEW

The proposed power station development will have impacts at both the construction and operational phases, which in some cases will be different. This section identifies the anticipated impacts during the construction phase and the magnitude of impact. In addition mitigative measures are proposed in order to prevent or minimise the impacts during construction.

Construction for is expected to commence towards the middle of 1994 and to last for approximately 3 years.

The construction phase will involve the following activities:-

(a) preparation of contractors area,
(b) site clearance,
(c) infrastructure buildings, roads, etc.,
(d) site building,
(e) installation of equipment,
(f) services connection.

The activities are expected to generate impacts of the following types on the local environment:-

(a) Waste disposal (site and sanitary),
(b) Traffic,
(c) Noise,
(d) Air Quality,
(e) Socio-economic.

WASTE DISPOSAL

The disposal of wastes, both sanitary and site generated, is a major consideration for the construction phase, in particular due to the relatively remote nature of the site.

Waste generated as a result of site clearance (mainly vegetative matter) will be burnt and buried.

A package sewage treatment facility will be installed on site. The construction phase is likely to involve a peak of in the region of 1500-2000 personnel on site. Sanitary waste from toilets and ablutions will be treated in this facility. Sludge from the package sewage treatment facility will either be burnt in an on-site incinerator, or disposed of in conjunction with NLC's facilities.

Waste water from the sewage treatment facility will be disposed to the sea.

Construction and general site rubbish will be disposed of to landfill, either on-site or at the nearest suitable facility.

7.3 TRANSPORT

Traffic associated with construction of the proposed power station will be related to transport of materials and plant to the site, and transport of construction personnel to site. A peak construction workforce of in excess of 1500 personnel is anticipated. It is expected that a large proportion of this workforce will reside in a construction camp on site, with some staying at the Neyveli township.

A traffic survey was done on a typical day, Friday 13th August 1993 at the intersection of main road and site road at the Neyveli complex gate. The traffic was divided into 3 categories (buses and lorries, vans and cars and bikes and carts) and flow in both directions was counted. The results are shown in Table 7.1 with Figure 7.1 showing a graphical representative of the results. Figure 7.2 shows each category individually with school, office and power station shift times marked also.

From this data several observations can be made and include:

- Buses and lorries form the majority of traffic both along main road and site road.
- The majority of buses and lorries pass Neyveli without entering.
- The majority of cars and vans, bikes and carts travel in and out of Neyveli, rather than being through traffic passing Neyveli.
- A significant peak of buses and lorries, most likely buses, occurs preceding school start and following school finish suggesting a significant number of school children come from surrounding areas.

- This trend is not repeated surrounding office times or shift times indicating the known fact that most workers live within Neyveli.

Figure 7.2 for Bus and Lorry traffic, also shows the estimated flows for a 24 hour period. This estimate is based on observations by local people and suggests an increase in lorry traffic during the night. Most of this traffic is passing Neyveli and reflects the role of main road as a significant route for freight between Madras and the southern regions of India.

At present the road network and traffic in Neyveli is simple and of a relatively small scale, with many locals still relying on simple transport techniques such as walking, cycling or using motor bikes.

However, traffic contributes to several environmental problems which include the following:

- dust creation,
- exhaust emissions,
- land use impact of roads,
- natural resources use (i.e. fuels).

Generally these are at a level expected for a developing town with an industrial base. However, much of the Neyveli area is till a rural community and so any increase in roads or road traffic will bring an increase in the impacts mentioned above, along with an increase in the living standards of the people.

During the construction phase of this project a significant increase in materials and equipment being brought in by road to Neyveli can be expected. This will have the effect of adding to the flow of lorries along the "main" road and into Neyveli via "site" road. The project during construction would expect to attract an additional 50 to 100 trucks and lorries per day and it is anticipated that these figures could be easily accommodated by the present road infrastructure.

However, as suggested by local observation the busiest period for lorries at present is during the night while all construction traffic will be during the day. So traffic congestion should not be a significant problem. Perhaps some planning should be done to avoid construction traffic operating during the periods just before and just after school times when school buses are operating.

Increased dust and exhaust emissions would be expected during construction, but these would only create short term degradation of local air quality.

Given that the construction workforce will be living in Neyveli no significant increase in traffic would be expected during the construction phase. It is anticipated that buses will be the main form of transport for workers to and from the site which will help reduce the impact of increased traffic within the Neyveli township during the construction phase.

Further afield the progress of heavy freight traffic from Madras (the most likely port for delivery of equipment and materials) should be considered. In particular the ability to transport large items of equipment should be assessed (e.g. load and size limits on bridges, roads, etc.). Given that Neyveli has other heavy industry it could be assumed that transport of heavy freight to the site should not create any problems. However this should be confirmed at the design stage to assess whether complete units can be freighted in or whether units need to be freighted in smaller component parts.

As an alternative, rail transportation could be considered as Neyveli is serviced by the India network from Madras. The availability of this form of transport should be investigated by potential contractors.

In view of the low volume of additional traffic, the increased number of vehicles using the road during this time will have an insignificant effect and is not expected to cause disruption to the traffic flow.

7.4 NOISE

As there are no residential areas within the site and the nearest being almost 1-3 km away, noise from the construction activities is not considered to be a problem. However, the workers would be protected through the Contractors Health and Safety code of practice.

The two main sources of noise associated with construction are likely to be from:

- heavy goods vehicles to and from the site, and
- the construction works themselves.

Noise from increase in traffic movements, as discussed earlier, is considered to be insignificant.

Construction noise will be generated over a significant period of time, especially whilst excavation takes place. We anticipate that the construction noise will not be particularly noticeable as the nearest residential complexes are almost 1-3 km from the site.

7.5 AIR QUALITY IMPACTS FROM CONSTRUCTION ACTIVITIES

Dust and grit are expected to be present during the construction phase in dry months. This will end when the major civil works finish. Some dampening of the exposed areas may be necessary.

The principal pollutants associated with traffic are:

- sulphur dioxide,
- carbon monoxide,
- oxides of nitrogen,
- hydrocarbon emissions,
- dust.

The background level of these pollutants would depend on the existing traffic flow along the main routes. As the construction traffic is predicted to be a relatively small amount of the total projected traffic, any increase in these pollutants is considered to be insignificant.

It will also be necessary to ensure that loads are covered to prevent fine dusting blowing from open-top lorries. In dry periods, it may be necessary to dampen some adjacent roads at regular intervals.

7.6 SAFETY DURING CONSTRUCTION

The responsibility for safety on the construction site will be the Contractors'. If, at any stage, work is undertaken on the existing site, the Contractors will be bound by the relevant Indian standards as well as World Bank's guidelines on Occupational Health and Safety, as outlined in Appendix B.

On the site, the main Contractor's Project Manager will be directly responsible for ensuring the safe and proper execution of all on-site activities. To assist him, a senior member of the site project team will be nominated Safety Representative.

7.7 SOCIO-ECONOMIC ISSUES

The interface between social and economic factors and the proposed project is seen in the following areas during the construction phase:

- nuisance and disruption from extra traffic,
- noise nuisance from the construction activities,
- workforce requirements,
- economic benefits to the local community.

The first two are dealt with under noise and transport; the last two are discussed here.

A project workforce in excess of 1500 workers at peak is expected to be needed over the construction period. This workforce would consist of:

Civil and building services	- 50 %
Mechanical	- 20 %
Electrical	- 15 %
Professional, managerial, administration	- 15 %
TOTAL	**100**

The unskilled and semi-skilled workforce is expected to come from the local area and overseas. A majority of the skilled workforce is expected to come from other parts of India.

The relatively small number of workers coming into the area will not affect housing availability. These workers would be accommodated on site.

7.8 IMPACTS ON ECOLOGY

7.8.1 Construction Impacts on Flora

The impact on the flora due to construction activities would be mostly confined to those in terrestrial habitats. Construction of the power station would involve the building of the power house, switch-yard, heavy fuel oil fuel storage, and permanent access roadways.

Construction of the power house would inevitably result in the clearing of nearly all vegetation from the site. Majority of the plants that would be cleared are species found to be commonly growing in the surrounding environs. Thus the impact when viewed on a loss of species diversity is insignificant and will be outweighed by the benefits that will result from project implementation.

The other new permanent land take areas are mainly for switchyard administration offices and access road ways. The direct loss of species diversity and habitats may be considered to be insignificant for the same reasons specified above and due to the limited area involved.

The flora in the immediate environs of the construction sites would be impacted by dust/grit generated during the construction activities. This would temporarily impair the growth of the impacted flora and any damage would not be of permanent nature.

The temporarily affected area such as the lay down area, road ways and dump sites should be restored or rehabilitated with appropriate landscaping and planting.

The adverse impacts on the flora due to construction could be regarded as within acceptable limits.

7.8.2 Construction Impacts on Fauna

The impacts on the fauna during the construction activities would be mostly confined to those affecting the terrestrial faunal habitats. This is because the aquatic habitat is impacted by effluents discharging from the plant and effluents are predominantly generated during plant operation.

The construction impacts on the terrestrial component would arise due to habitat changes that would be brought about by the envisaged construction activities. Such habitat alterations can become permanent features associated with the new plant layout or be temporary measures that have to be adopted in order to complete construction requirements. Thus, impacts could be categorised under permanent impacts and temporary impacts. Plant construction activities will result in permanent impacts. Temporary impacts would arise from the dust/grit originating from construction activities, clearing land clearance activities for the temporary access roadways and habitat changes at the lay-down site.

Temporary impacts are reversible provided the physical extent impacted is relatively small and the involved time frame is short. Fortunately, the envisioned temporary impacts due to the above-outlined construction activities would affect only a small area. Adverse impacts could be reduced further by carrying out rehabilitation of the disturbed areas as speedily as possible and by minimising the time period over which the habitat remains in a disturbed state. As regards the laydown area, adverse faunal impacts would be minimal due to its degraded condition, but even so proper adoption rehabilitation measures will be considered for this site. Another important consideration that is regularly overlooked in many projects is the improper disposal of post-construction unusable material at "temporary" dumping sites over a long time frame, thereby transforming anticipated temporary impacts into very undesirable permanent impacts on the habitat. The proper restoration of temporarily used areas will be a specific stipulation that requires stringent implementation if such undesirable impacts are to be avoided.

The permanent impacts of the project that are related to construction are unavoidable, but in this project, these are confined to relatively small areas. A more important consideration that would lead to minimising the adverse impacts on the faunal component is because the permanently affected areas do not harbour a unique faunal assemblage.

Therefore, it can be stated that adverse faunal impacts due to construction will be limited to acceptable levels by following the recommended mitigatory measures described above.

7.9 OTHER IMPACTS

7.9.1 Background

In addition to the above main impacts, we would anticipate a number of minor impacts associated with the following activities:-

- Groundwater drainage,
- Piped services.

7.9.2 Ground Water Drainage

A land drainage system will be provided during the site construction phase This system will direct both the ground water and surface run off to the nearest canal.

7.9.3 Piped Services

Preliminary site works will require the laying of a number of piped services, such as sewage, water main, oil interceptor drains and signal cables. During the laying of these piped services, any on-site roads may need to be dug up and there will therefore be some temporary disturbance. Ultimately, a majority of piped services will be buried and thus cause no long-term obstruction.

Table 7.1

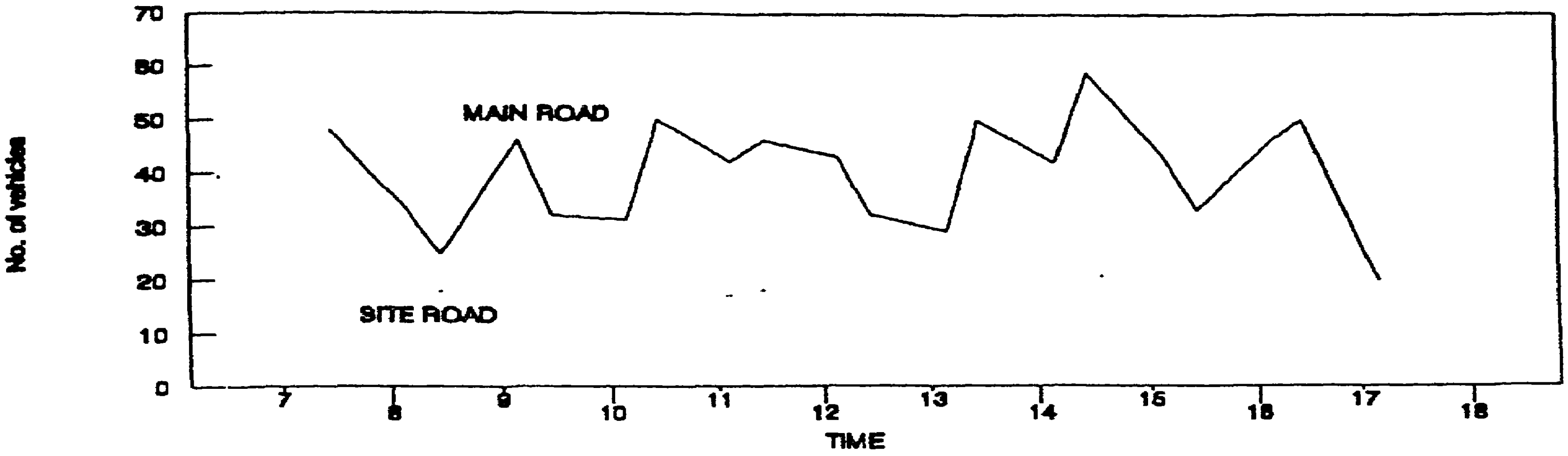
TRAFFIC SURVEY DATA
Neyveli Lignite Fired Power Station – EIA

Time	Traffic					
	Main Road			Site Road		
	A	B	C	A	B	C
7.45	48	7	9	32	22	16
8.15	33	10	7	18	22	9
8.45	25	10	11	18	5	18
9.15	46	11	13	20	16	16
9.45	32	12	16	14	7	17
10.15	31	11	15	17	9	12
10.45	50	14	17	16	16	24
11.15	42	11	13	17	4	12
11.45	46	13	6	18	10	9
12.15	43	11	6	17	6	10
12.45	32	11	10	9	7	18
13.15	29	11	8	15	8	10
13.45	50	26	11	25	17	8
14.15	42	17	18	18	11	8
14.45	59	13	9	21	14	12
15.15	43	22	4	19	17	10
15.45	33	13	7	16	11	8
16.15	46	18	20	31	18	20
16.45	50	26	15	23	22	17
17.15	20	6	4	13	5	5
Sub Totals	800	273	219	377	247	259
Totals			1292			883

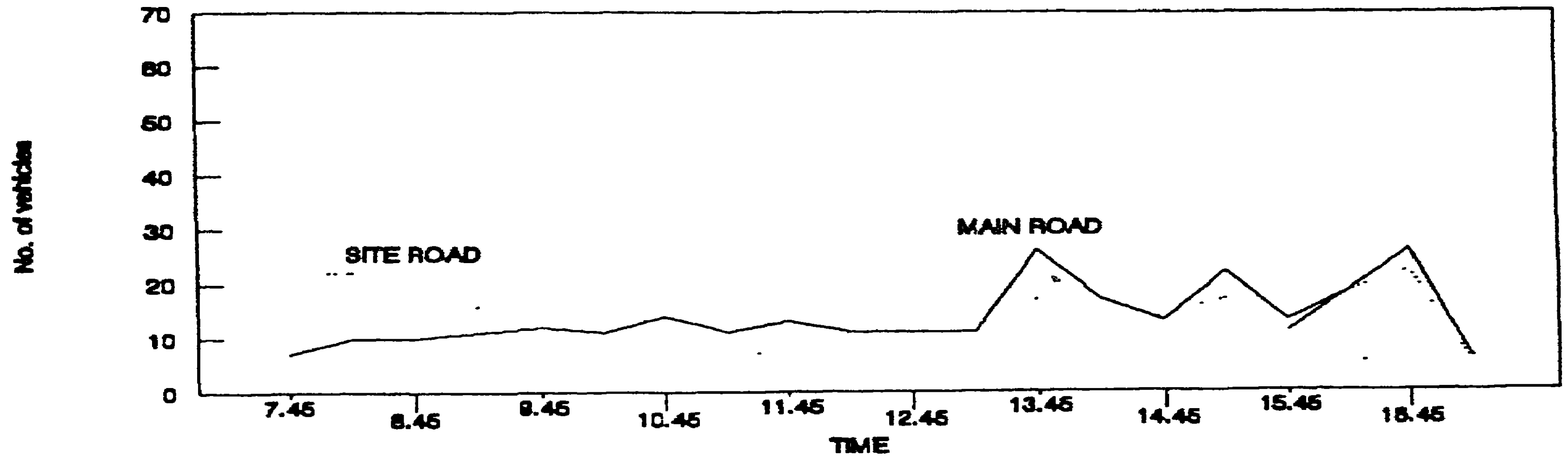
KEY:
A – Lorries and Buses
B – Vans and Cars
C – Bikes and Carts

TRAFFIC SURVEY BY CLASS

(A) BUSES AND LORRIES



(B) CARS AND VANS



(C) BIKES AND CARTS

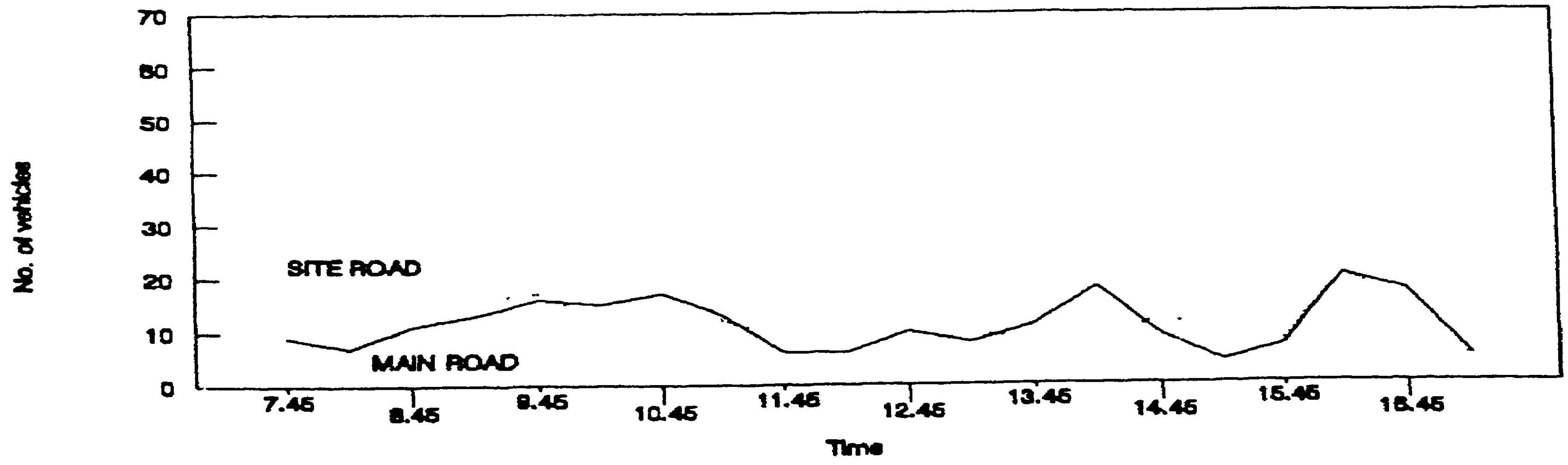


FIGURE 7.1

BUS & LORRY TRAFFIC ESTIMATE

(For a 24 Hour Period)

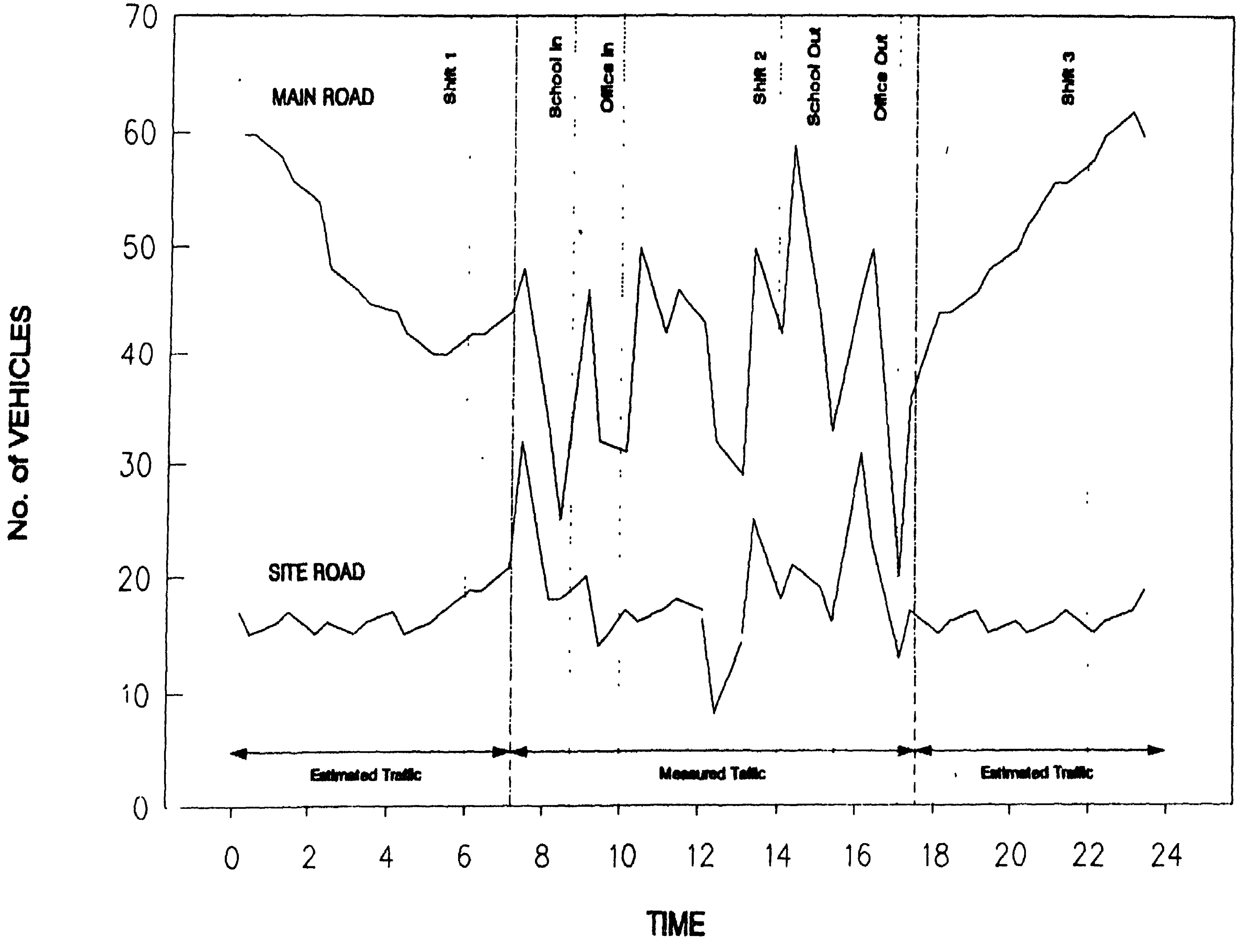


FIGURE 7.2

SECTION 8

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES DURING OPERATION

SECTION 8

OPERATIONAL IMPACTS AND MITIGATION MEASURES

8.1 OVERVIEW OF IMPACTS

The major activities of this stage of the project involve operation and maintenance to ensure smooth running of the power plant and associated equipment. Furthermore, it is essential that the residential complex is provided with all the required services including provision of potable water and solid waste disposal. During the operational stage of the power plant, it is anticipated that there will be impacts on:

- air quality,
- noise,
- water discharge,
- socio-economic environment,
- ecology,
- visual intrusion, and
- solid waste disposal.

These impacts are discussed in detail to ensure that the relevant regulations and standards are not exceeded and that the appropriate mitigation measures have been incorporated into the plant design.

8.2 OVERVIEW OF MITIGATION MEASURES

Atmospheric pollutant emissions will be controlled at source by the following mitigation measures:

Sulphur dioxide - a stack height of 220 m will be provided to enhance dispersion. No emission standards exist at present.

Nitrogen dioxide - low-NO_x burners will be provided to control NO_x emissions to below 260 ng/J (650 mg/Nm^3) at 6% oxygen in dry flue gas.

Particulates - a high efficiency electrostatic precipitator will be provided to comply with 150 mg/Nm^3 particulates limit at 5% oxygen in dry flue gas.

Boiler blowdown and demineralisation plant effluents will be treated for pH and other parameters prior to discharge to ensure compliance with the Indian and World Bank guidelines.

Noise will be controlled during the design application to ensure compliance with the World Bank guidelines. 70 dB(A) value will be achieved at the site boundary.

Ash will be disposed of in wet form in a controlled manner at a dedicated disposal pond. Overflow from this pond will be monitored. Utilisation of ash will be explored and where practicable implementation of these techniques will be underatken either by the developer or in association with other organisations.

A monitoring programme during operation for noise, air quality, water discharge and abstraction and ecological disturbance will be implemented to assess the status of these impacts during the early years of power plant life. Based on this status report, appropriate mitigatory measures will be taken.

8.3 IMPACTS ON AIR QUALITY

8.3.1 Introduction

The combustion of fossil fuels for power generation inevitably results in emission of gaseous pollutants to the atmosphere. As the Neyveli power plant will be fired with lignite, the pollutants of potential concern are sulphur dioxide, oxides of nitrogen expressed as NO_2, carbon monoxide (CO), carbon dioxide (CO_2) and particulates. Each of these pollutants is examined below to ensure that both MOEF and World Bank limits will be complied with and, where appropriate, the required emission control techniques are incorporated into the plant design.

When it was established that atmospheric emission limits at source would need to be met, detailed dispersion modelling was carried out to demonstrate that the relevant air quality limits will not be approached or exceeded.

8.3.2 Atmospheric Pollutant Emissions

The anticipated uncontrolled NO_x, SO_2, particulates and CO_2 emissions from the Neyveli lignite power plant are shown in Table 8.1, along with emission limit for each pollutant. The values indicate that the installation of emissions control techniques will be necessary in order to meet the relevant emission limits for particulates and nitrogen oxides.

Emissions of SO_2, NO_x and particulates will be controlled as follows:

- SO_2 emissions will not be controlled because:
  - i) there is no emission limit for Indian Standards and
  - ii) the total emissions as tonnes per day are below the World Bank guidelines given in Table 1.1.
- NO_x emissions will be controlled by installing low - NO_x burners to comply with the World Bank's emission limit of 260 ng/J (650 mg/Nm^3) for lignite fuels.
- Particulates emissions will be controlled by installing high efficiency electrostatic precipitator to comply with World Bank and Indian Standards of 150 mg/m^3.

There are no World Bank limits for CO or CO_2 emissions because generally almost complete combustion of the fuel is expected in the boilers.

Following the incorporation of the appropriate emissions control techniques to meet atmospheric emission limits, the following mass emissions of pollutants are expected from the Neyveli lignite power plant, based on a worst case scenario of burning lignite with 0.6% sulphur content:

Pollutant	**Emissions (tonnes/day)**
SO_2	42
NO_x	19
CO	3
CO_2	7687
particulates	4

8.2.3 Stack Parameters

These pollutants will be discharged to the atmosphere via a chimney of 220 m height to provide sufficient dispersion so as to render the pollutants harmless at ground level and to ensure that air quality limits are not exceeded. The 220 m height is required to comply with the Indian Equipment Standard to disperse SO_2.

The diameter of the chimney will be between 5.7 to 6 m at the tip.

8.3.4 Air Pollution Modelling

8.3.4.1 General

Air pollution is generally a major problem during the operational phase of a power plant. Particulate matter, SO_2 and NO_x, etc. are emitted from the stacks and, if not controlled, can lead to severe impacts on the air environment. Concentration of different pollutants above a super critical level can cause injury and disease to plant, animal and human life. Epidemiological studies relate the dosage or exposure to pollution to adverse health effects on living beings. Air quality criteria are derived from such epidemiological studies. Air quality standards are based on air quality criteria with added safety factors as desired. Air quality standards prescribe pollutant levels that cannot be legally exceeded during a specific time period in a geographical area. The emissions of air pollutants (as listed above), therefore, need to be controlled so that the ground level concentrations (GLCs) for these pollutants do not exceed the ambient air quality standards specified by the TNPCB. The problem of lignite dust dispersal during lignite handling is also anticipated. However, the proposed project will be sited near the mouth of the lignite mines and hence, no increase in lignite dust dispersal in atmosphere is involved. Moreover, lignite is a high moisture fuel (with about 48% moisture), and the problem of dust generation in handling is very small. However, tunnels and sensitive areas would be provided with dust suppression and extraction systems. Air pollution control measures that are proposed to be taken for controlling emission of other pollutants in the proposed power plant have been discussed above.

The real concern with pollution emission from power plants is the human exposure to these pollutants. The concentration at ground level is therefore an important indicator. As explained earlier, air quality is a measure of the concentration of air pollutants taken continuously or intermittently over a short or long period of time - each measurement of which represents an average concentration over a certain period of time. Air quality of an area can, therefore, be determined either through a network of monitoring stations over the area or through simulation of air quality through mathematical modelling. However, prediction of air quality due to any future activity can only be done using the latter technique.

The ambient GLCs of pollutants not only depend on rate of emissions and the stack height, but also on the meteorological features such as wind speed, stability conditions, etc. Also, the efficiency of dispersion or the avoidance of plume droop depends not only on the height of the stack but also on the temperature and velocity at which the flue gas is released to the atmosphere. To predict the GLCs, it is necessary to simulate the dispersion of pollutants under atmospheric conditions (wind speeds, stability, etc) using air quality models. Air pollution modelling simulates the manner in which wind and atmospheric turbulence disperses and transports the pollutants in the air.

8.3.4.2 Applications of TERIMAQ To the Proposed Plant

The point source model of TERIMAQ Version 1.0 has been applied to estimate the impact of the proposed 210 MW lignite based power plant in Neyveli on the ambient air quality.

For this study a spatial scale of up to 18 km is used. The time scales used are short-term (8 hourly) and long-term (annual). The three pollutants that have been considered are SO_2, NO_x and TSP.

The input data for the dispersion modelling is shown in Tables 8.2 and 8.3 for short-term and long-term modelling, respectively. Data input for the long-term modelling is based on an annual plant load factor of 85%.

8.3.4.3 Short-term Average Concentrations

From atmospheric data, it was seen that the entire range of atmospheric stabilities were present during different times of the year. GLCs of pollutants emanating from tall stacks are high under inversion conditions in the atmosphere and could exceed the ambient air quality standards. From the regulatory context, it is important that the ambient air quality should not exceed the standard. Fortunately, inversions are rare over Neyveli. Hence, TERIMAQ has been used to estimate the short-term GLC due to the proposed power plant under very unstable conditions at three representative wind speeds in the region for three pollutants - TSP, NO_x and SO_2.

The annual average wind speed is approximately 2.1 metres per second. To cover the entire range of wind speeds and stability, the model was initially run for very unstable, neutral and stable atmospheric conditions for three wind speeds that ranged from low (0.139 m/s), average (1.215 m/s), and to a high (3.17 m/s). It was observed that stable and neutral conditions give rise to a very high plume rise and consequently very low GLCs in the range of 18 km and beyond. However, unstable conditions give rise to higher levels of GLCs.

Figures 8.1, 8.2 and 8.3 show a short-term SO_2, NO_x and TSP concentrations under very unstable atmospheric conditions. As can be seen, higher wind speeds produced higher GLCs near the plant.

The following observations need to be note:

- Maximum GLCs equal 122, 100 and 8 $\mu g/m^3$ of SO_2, NO_x and TSP respectively and occur at a distance of 1 km and at a wind speed of 3.17 m/s.
- Maximum GLCs equal 120, 99 and 8 $\mu g/m^3$ of SO_2, NO_x and TSP occurring at a distance of 1.3 km and at a wind speed of 1.2 m/s.
- Maximum GLCs equal 51.5, 42.0 and 3.3 $\mu g/m^3$ of SO_2, NO_x and TSP at a distance of 3.1 km and at a wind speed of 0.14 m/s.
- At a distance greater than 3.1 km higher wind speeds produced lower concentrations. This is because wind speeds affect GLCs in two ways. Higher wind speeds produce lower plume rise which in turn increases GLCs nearer to the plant. However, higher wind speeds also increase dispersion and therefore, at further distances there is a reduction in GLCs.

It is clear from the above that the peak of the GLC profile is maximum at the "high" wind speeds of 3.17 m/s and occurs within 2 km of the proposed plant. Maximum GLC at low wind speeds is about half of the maximum GLC under the high wind conditions. Peak GLC under all wind conditions occurs within 4 km of the proposed plant. Maximum short-term GLC of TSP is only about 8 $\mu g/m^3$ due to the proposed installed of an electrostatic precipitator. The maximum short term concentration of NO_x and SO_2 is about 100 $\mu g/m^3$ and 120 $\mu g/m^3$.

Both these GLC values are close to the Indian ambient air quality standards for industrial areas for very unstable conditions. For neutral and stable conditions the GLC values, once added to the existing background levels, would still comply with the 8 hourly air quality limits for all pollutants. However, the GLC values for very unstable conditions would not be a significant problem as these conditions are normally experienced in Neyveli for less than 2-3% of the year. If the standards are applied on a 95 percentile basis, the Neyveli lignite plant would comply with the limits for SO_2 and NO_2 as set by TNPCB. All the values are well below the World Bank's limit of 500 $\mu g/m^3$ for both particulates and SO_2 on a 24 hour basis.

8.3.4.4 Long-term Annual Average Concentrations

Average annual GLC of the three pollutants have been calculated using the annual wind rose and stability distribution of Madras. The most dominant wind direction is towards north east (NE) followed by south west (SW). Table 8.4, 8.5 and 8.6 show the average annual ground level concentration of TSP, SO_2 and NO_x in 16 wind directions around the proposed power plant. Maximum GLC occurs at approximately 6.5 km from the plant in the NE direction.

Maximum GLC of TSP in the NE and SE directions are 0.2 and 0.1 $\mu g/m^3$ respectively. Maximum GLC of NO_x in the NE and SW directions are 2.0 and 1.5 $\mu g/m^3$ respectively. Maximum GLC of SO_2 in the NE and SW directions are 1.8 and 2.4 $\mu g/m^3$ respectively. As can be seen the contribution from this plant is fairly low (maximum GLC is around 0.2, 2.4, 2.0 $\mu g/m^3$ for TSP, SO_2 and NO_x respectively).

If these value are added to the monthly averages quoted in Table 4.9, the predicted long-term averages are well below the World Bank's annual limit of 100 $\mu g/m^3$ for particulates, SO_2 and NO_2, as shown in Tables 8.7 and 8.8. On an annual basis, the project background levels will occupy less than 10% of this SO_2 annual limit and 15% of the NO_2 limit.

The predicted annual average concentrations of SO_2 and NO_2 are relatively low in comparison with the hourly peak values because annual dispersion modelling takes into account the following historical data:

- wind directions,
- wind speeds,
- Pasquill Stability Categories
- load factor.

8.4 WATER ABSTRACTION AND DISCHARGE

8.4.1 Water Abstraction

Water will be abstracted from ground water to provide the water requirements for the following:

- make-up cooling water for the power plant condensers,
- feed water to the desalination plant.

Bore hole results have shown that there is sufficient ground water for abstraction without disturbing the local supply of water based on wells and hand-pumps. Furthermore, penetration of seawater is not expected, as discussed in Section 4.

8.4.2 Water Discharge

8.4.2.1 Background

The power station will have a relatively large number of waste water streams and the principal ones are listed below:

- ash pond overflow,
- cooling water from the condensers,
- boiler blowdown,
- effluent from the water treatment plant,
- effluent from the sewage treatment plant,
- surface run-off,
- others (spillages, washing, etc.).

These streams are discussed below in terms of quantity of effluent produced along with the discharge options.

8.4.2.2 Ash Disposal

As discussed previously in this section of the report, the ash content in the fuel can vary from 2.5% to 12%. The average ash content is assumed to be 8.84%. The inclusion of up to 14% overburden material in the lignite supply could increase this average value significantly. However, the frequency and duration of periods when overburden inclusions occur, should not raise this average above 10% ash content in the fuel. Based on the projected maximum fuel burn of 7200 tonnes/day, the average ash production would be in the order of 720 tonnes/day. Like the existing power plant of NLC, the fly ash and bottom ash would both be discharged in the form of the ash slurry to ash dump yard to be constructed.

Decantation of water from the ash slurry will take place in the dump yard and the decanted water will be recycled to the ash slurry system The pH of the ash slurry is slightly on the alkaline side (say 8.5) and there seems to be no problem in dealing with effluents from the ash dump yard. The water from the ash lagoon will be recycled to the ash handling system to form a closed cycle thus minimising the risk of any water pollution by this effluent. Any overflow from the ash water recycling system will be discharged via an effluent pit for treatment and satisfactory disposal off site. Weekly analysis of decanted ash dump yard effluent will be carried out for pH, suspended solids, oil grease, as per Environment Protection Act (EPA) Rules 1986 (Rule 3, Schedule I) with the objective of monitoring the water quality.

8.4.2.3 Effluent from the Water Treatment Plant and Condensate Polishing Plant

The effluents from the water treatment plant (acid and alkali storage area, resins regeneration and back wash operations, other normal running operation of plant and laboratory, etc.) will be taken to the effluent treatment plant (ETP). The ETP will have facilities to neutralise and treat the effluent so that it becomes acceptable to be used in the ash handling systems. 2 x 100% duty condensate polishing plant units be provided to process the total flow of condensate to the boiler and maintain the specified minimum solids condensate quality requirements.

Similarly the effluents from the condensate polishing plant will also be neutralised, treated and then used. This facility for treatment of both effluents may be separate or common. The treated effluent will be utilised in the plant itself.

8.4.2.4 Thermal Pollution of Water

Since a closed cycle cooling water system will be used, passing hot water through cooling tower for cooling it, there will be no thermal pollution of the water. Small amounts of blow down from hot water side of closed cycle will be used for ash handling. The ash slurry is pumped to the ash dump yard from where the decanted water is recycled. By the time this water flows back, it is already cooled. The temperatures at various points will, however, be measured and recorded.

8.4.2.5 Steam Generator Blow Down

A few tonnes of blowdown from the steam generator side (the separator vessel of the once through boiler and other blow downs) will be safely led to the ash water slurry trench where its heat and alkalinity is lost after mixing with large quantities of ash slurry and it loses all pollution potential.

The blowdown will be analysed weekly for pH, suspended solids, oil, grease, copper and iron. Ash pond water return will also be checked weekly for pH, suspended solids, and oil and grease. All return water from the ash point or ash dewatering bins will be recycled to the power station.

8.4.2.6 Oil and Grease Leakages

Fuel oil decanting, storage and pumping facilities will be created for the station. Oil recovery from the effluent from the oil decanting area, blowing of sludge and moisture from fuel oil tanks and heaters, system leakages will be carried out by decanting and pumping of oil. The sludge would be separately disposed of. The lubricating oil from system leakages will also be decanted and suitably used according to its quality. Old oil will normally be cleaned and put to some use. Sludge will be separately disposed of.

8.4.2.7 Sewage Disposal

Sewage from bathrooms of various buildings will be treated in various septic tanks locally constructed. The effluent from the septic tanks will be dispersed in trenches where there is no change of its mixing with other water streams. The sludge from septic tanks will be periodically disposed off as manure. No pollution on account of sewage is therefore envisaged.

8.5 SOLID WASTE MANAGEMENT

8.5.1 Types of Solid Waste

A number of solid wastes will be generated at the site, the major ones being:

- municipal solid wastes (if any)
- sewage sludge from the sewage treatment plant
- general power station waste
- ash.

8.5.2 Disposal Options

The following wastes will be landfilled at a suitable site:

- sewage sludge
- general power station waste

The ash management has been discussed in Section 3 with a view to landfill and utilisation.

8.6 SOCIO ECONOMIC IMPACTS

8.6.1 Population and Communities

The operation of the new power station at Neyveli will result in new workforce coming in the Neyveli township, made up of the power station workers and their families. This community is expected to number up to 1000.

The local secondary school population may, therefore, increase. There will also be inevitable interaction between the power station staff and their families with the local communities.

8.6.2 Employment and Income

The addition of the community associated with the Neyveili-Lignite power station will have very little impact on services and facilities in the surrounding area as the addition of 1000 persons to Neyveli township will be insignificant, recreational, religious, medical and primary education facilities will be located within the Neyveli township provided by NLC.

It is inevitable, however, that some benefits will reach the local towns in the form of money being spent there by the new community.

8.6.3 Industrial Development

On a state scale, the proposed power station will have a positive impact on industrial development by the addition of a new source of power to meet demand.

8.6.4 Road Development

The operation of the power station will not result in road development in the general area. The only development will be the access road to the power station, and roads within the power station site.

8.6.5 Historical Sites

There will be no impact of the proposed power station on historical sites, as there are none located within the area of influence of the power station.

8.7 IMPACTS ON ECOLOGICAL SYSTEMS

The following activities may directly or indirectly affect the ecological setting in a region:

- Human activities
- Noise levels
- Land degradation
- Deforestation
- Air quality

In this case, only the first two activities could have some impact on the ecological setting. However, there is extensive human activity in the region even without this project. This is primarily due to a number of other industrial activities in the area. Most of the flora that now exists in the area is due to the efforts under the afforestation programme of the NLC. The construction of the proposed plant will, therefore, not have any significant impact on the flora and fauna. The animal species identified in the area seem to have adapted themselves to the surrounding environment and hence would be least affected. As far as the flora specifies are concerned, there is no endangered or rare flora species in proximity of the proposed plant. The most important aspect is that the flora and fauna which are represented here in this site are also represented elsewhere in the state and in the country; hence there is no danger of damage to the biological environment.

8.8 NOISE

8.8.1 Noise Sources

All of the primary sources of noises from the proposed site will be designed and operated to have a total noise level not exceeding 85 dB(A) at 1 m.

8.8.2 Predicted Noise Levels

The maximum sound pressure level stated above was used in conjunction with mathematical equations in order to model attenuation of noise due to distance in the design. These equations do not take into account attenuation due to buildings or the use of mitigatory techniques and thus provide a worst case scenario.

From these investigations, the proposed power station is not expected to add significantly to the outside noise baseline and excessive levels outside buildings are not expected. The World Bank noise guidelines referred to earlier will not be exceeded during operation. Therefore, the main noise mitigation measures will be designed to limit indoor noise and, in order to protect the hearing of workers, the contractor will provide noise suppression enclosures around noisy plant items.

When operating, staff may have to enter areas where the sound pressure level exceeds 80 dB(A). In such cases access doors should be clearly marked to indicate a noise hazard and ear protection muffs should be worn.

Table 8.1

ANTICIPATED EMISSIONS FOR NEYVELI LIGNITE POWER STATION

	Lignite Fuel
MWe	250
Assumed efficiency, %	30.5
MWth input	820
Fuel burn, kg/s	81
Fuel sulphur, %	0.6
Dry flue gas volume, Nm^3/kg	11.06
Dry flue gas volume, Nm^3/s	329
Uncontrolled SO2 emission, mg/Nm^3	1477
SO2 emission, g/s	485
NOx emission, ng/J	260
NOx emission, mg/Nm^3	650
NOx emission, g/s	214
Particulate emissions limit, mg/Nm^3	150
Particulate emissions limit, g/s	49
CO_2 emissions, t/day	7690

Table 8.2

NEYVELI LIGNITE POWER STATION

Data inputs to Short Term Air Quality Models

	PHASE 1
NOx emissions (g/s)	214
SO2 emissions (g/s)	485
Stack velocity (m/s)	25
Stack temperature (K)	415
Stack diameter (m)	6.0
Stack height (m)	220

Table 8.3

NEYVELI LIGNITE POWER STATION

Data inputs to Long Term Air Quality Models

	PHASE 1
NOx emissions (g/s)	182
SO2 emissions (g/s)	413
Stack velocity (m/s)	25
Stack temperature (K)	415
Stack diameter (m)	6.0
Stack height (m)	220

Table 8.4

Average Annual Ground Level Concentrations of SO_2 in 16 Wind Directions from the Proposed Power Plant at Neyveli (250 MW Lignite based)

Distance (metres)	Concentration (microgram/m ^ 3)															
	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE	N	NNW	NW	WNW
500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1000	0.027	0.107	0.483	0.269	0.175	0.135	0.161	0.027	0.135	0.201	0.551	0.269	0.135	0.135	0.282	0.148
1500	0.174	0.150	1.075	0.647	0.584	0.323	0.497	0.174	0.323	0.341	1.509	0.647	0.323	0.323	0.733	0.410
2000	0.115	0.153	0.978	0.536	0.440	0.268	0.383	0.115	0.268	0.383	1.265	0.536	0.268	0.268	0.593	0.325
2500	0.086	0.186	0.952	0.503	0.351	0.250	0.317	0.086	0.250	0.417	1.117	0.503	0.250	0.250	0.535	0.285
3000	0.053	0.206	0.990	0.522	0.341	0.261	0.314	0.053	0.261	0.439	1.125	0.522	0.261	0.261	0.549	0.288
3500	0.081	0.236	1.149	0.633	0.439	0.316	0.397	0.081	0.316	0.475	1.352	0.633	0.316	0.316	0.672	0.356
4000	0.127	0.260	1.352	0.775	0.577	0.388	0.513	0.127	0.388	0.515	1.668	0.775	0.388	0.388	0.837	0.451
4500	0.173	0.282	1.541	0.907	0.714	0.455	0.627	0.173	0.455	0.546	1.973	0.907	0.455	0.455	0.994	0.541
5000	0.209	0.295	1.675	1.008	0.817	0.504	0.713	0.209	0.504	0.565	2.200	1.008	0.504	0.504	1.112	0.608
5500	0.233	0.301	1.754	1.069	0.865	0.532	0.767	0.233	0.532	0.567	2.338	1.069	0.532	0.532	1.184	0.650
6000	0.248	0.297	1.781	1.092	0.919	0.547	0.795	0.248	0.547	0.562	2.400	1.092	0.547	0.547	1.216	0.671
6500	0.255	0.293	1.776	1.097	0.930	0.548	0.803	0.255	0.548	0.550	2.412	1.097	0.548	0.548	1.225	0.675
7000	0.257	0.285	1.748	1.085	0.928	0.543	0.800	0.257	0.543	0.533	2.390	1.085	0.543	0.543	1.214	0.671
7500	0.259	0.275	1.708	1.066	0.919	0.534	0.786	0.259	0.534	0.514	2.350	1.066	0.534	0.534	1.195	0.661
8000	0.256	0.268	1.668	1.043	0.905	0.520	0.777	0.256	0.520	0.498	2.305	1.043	0.520	0.520	1.171	0.650
8500	0.252	0.259	1.628	1.018	0.888	0.511	0.763	0.252	0.511	0.479	2.261	1.018	0.511	0.511	1.146	0.636
9000	0.250	0.248	1.587	0.997	0.875	0.498	0.748	0.250	0.498	0.464	2.210	0.997	0.498	0.498	1.121	0.623
9500	0.247	0.239	1.547	0.978	0.860	0.486	0.733	0.247	0.486	0.448	2.168	0.978	0.486	0.486	1.101	0.610
10000	0.244	0.232	1.515	0.957	0.844	0.476	0.722	0.244	0.476	0.436	2.128	0.957	0.476	0.476	1.077	0.599
10500	0.242	0.226	1.481	0.935	0.833	0.468	0.712	0.242	0.468	0.425	2.087	0.935	0.468	0.468	1.056	0.590
11000	0.240	0.220	1.451	0.916	0.818	0.459	0.697	0.240	0.459	0.411	2.048	0.916	0.459	0.459	1.038	0.579
11500	0.237	0.213	1.421	0.898	0.805	0.450	0.685	0.237	0.450	0.402	2.012	0.898	0.450	0.450	1.018	0.568
12000	0.234	0.207	1.392	0.882	0.792	0.441	0.673	0.234	0.441	0.392	1.976	0.882	0.441	0.441	0.998	0.558
12500	0.230	0.200	1.365	0.866	0.777	0.432	0.661	0.230	0.432	0.384	1.943	0.866	0.432	0.432	0.980	0.547
13000	0.227	0.196	1.339	0.848	0.767	0.426	0.653	0.227	0.426	0.377	1.910	0.848	0.426	0.426	0.963	0.540
13500	0.225	0.192	1.314	0.833	0.755	0.417	0.642	0.225	0.417	0.367	1.875	0.833	0.417	0.417	0.945	0.530
14000	0.222	0.188	1.289	0.818	0.743	0.408	0.631	0.222	0.408	0.361	1.845	0.818	0.408	0.408	0.929	0.520
14500	0.218	0.183	1.266	0.803	0.729	0.401	0.620	0.218	0.401	0.352	1.814	0.803	0.401	0.401	0.912	0.511
15000	0.216	0.178	1.243	0.788	0.717	0.394	0.607	0.216	0.394	0.348	1.779	0.788	0.394	0.394	0.898	0.501
15500	0.212	0.177	1.220	0.775	0.705	0.389	0.600	0.212	0.389	0.338	1.749	0.775	0.389	0.389	0.880	0.493
16000	0.208	0.173	1.199	0.762	0.695	0.382	0.590	0.208	0.382	0.333	1.720	0.762	0.382	0.382	0.866	0.484
16500	0.205	0.168	1.178	0.749	0.682	0.376	0.581	0.205	0.376	0.327	1.694	0.749	0.376	0.376	0.852	0.478
17000	0.203	0.165	1.161	0.738	0.670	0.366	0.570	0.203	0.366	0.322	1.668	0.738	0.366	0.366	0.837	0.468
17500	0.199	0.164	1.144	0.724	0.662	0.362	0.562	0.199	0.362	0.319	1.641	0.724	0.362	0.362	0.823	0.464
18000	0.197	0.161	1.126	0.714	0.651	0.356	0.552	0.197	0.356	0.311	1.617	0.714	0.356	0.356	0.813	0.455

Table 8.5

Average Annual Ground Level Concentrations of NO_x in 16 Wind Directions from the Proposed Power Plant at Neyveli (250 MW Lignite based)

Distance (metres)	Concentration (microgram/m ^ 3) W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE	N	NNW	NW	WNW
500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1000	0.022	0.088	0.385	0.221	0.144	0.110	0.132	0.022	0.110	0.163	0.451	0.221	0.110	0.110	0.231	0.121
1500	0.142	0.123	0.880	0.530	0.479	0.265	0.407	0.142	0.265	0.280	1.236	0.530	0.265	0.265	0.602	0.337
2000	0.094	0.126	0.800	0.439	0.361	0.220	0.314	0.094	0.220	0.314	1.035	0.439	0.220	0.220	0.486	0.267
2500	0.055	0.152	0.781	0.411	0.288	0.206	0.261	0.055	0.206	0.343	0.915	0.411	0.206	0.206	0.438	0.233
3000	0.044	0.170	0.812	0.430	0.280	0.214	0.257	0.044	0.214	0.360	0.920	0.430	0.214	0.214	0.451	0.235
3500	0.066	0.193	0.941	0.518	0.358	0.259	0.325	0.056	0.259	0.390	1.106	0.518	0.259	0.259	0.551	0.292
4000	0.104	0.215	1.109	0.635	0.474	0.319	0.422	0.104	0.319	0.422	1.369	0.635	0.319	0.319	0.687	0.370
4500	0.142	0.231	1.263	0.743	0.585	0.371	0.514	0.142	0.371	0.448	1.616	0.743	0.371	0.371	0.814	0.443
5000	0.172	0.240	1.374	0.825	0.669	0.414	0.584	0.172	0.414	0.464	1.803	0.825	0.414	0.414	0.910	0.499
5500	0.193	0.247	1.436	0.875	0.723	0.437	0.628	0.193	0.437	0.465	1.915	0.875	0.437	0.437	0.971	0.535
6000	0.204	0.248	1.460	0.898	0.753	0.448	0.653	0.204	0.448	0.462	1.967	0.898	0.448	0.448	0.997	0.551
6500	0.209	0.241	1.457	0.899	0.763	0.450	0.657	0.209	0.450	0.453	1.978	0.899	0.450	0.450	1.004	0.554
7000	0.212	0.234	1.432	0.890	0.763	0.446	0.657	0.212	0.446	0.437	1.960	0.890	0.446	0.446	0.995	0.550
7500	0.211	0.227	1.401	0.874	0.753	0.437	0.648	0.211	0.437	0.421	1.928	0.874	0.437	0.437	0.980	0.543
8000	0.209	0.220	1.368	0.854	0.742	0.429	0.638	0.209	0.429	0.405	1.893	0.854	0.429	0.429	0.959	0.533
8500	0.207	0.210	1.333	0.836	0.729	0.418	0.624	0.207	0.418	0.393	1.851	0.836	0.418	0.418	0.940	0.522
9000	0.208	0.204	1.301	0.817	0.716	0.408	0.614	0.208	0.408	0.379	1.816	0.817	0.408	0.408	0.920	0.511
9500	0.204	0.197	1.270	0.803	0.702	0.400	0.602	0.204	0.400	0.369	1.778	0.803	0.400	0.400	0.904	0.501
10000	0.202	0.190	1.241	0.784	0.693	0.391	0.592	0.202	0.391	0.355	1.744	0.784	0.391	0.391	0.885	0.490
10500	0.199	0.183	1.215	0.768	0.682	0.382	0.583	0.199	0.382	0.348	1.711	0.768	0.382	0.382	0.867	0.481
11000	0.197	0.181	1.188	0.752	0.672	0.376	0.574	0.197	0.376	0.338	1.682	0.752	0.376	0.376	0.850	0.474
11500	0.195	0.174	1.163	0.739	0.659	0.368	0.563	0.195	0.368	0.330	1.648	0.739	0.368	0.368	0.835	0.467
12000	0.192	0.169	1.140	0.723	0.649	0.361	0.554	0.192	0.361	0.321	1.619	0.723	0.361	0.361	0.819	0.458
12500	0.189	0.165	1.120	0.710	0.636	0.355	0.544	0.189	0.355	0.316	1.591	0.710	0.355	0.355	0.803	0.448
13000	0.186	0.160	1.098	0.695	0.626	0.348	0.534	0.186	0.348	0.306	1.565	0.695	0.348	0.348	0.787	0.440
13500	0.183	0.157	1.075	0.683	0.617	0.340	0.523	0.183	0.340	0.301	1.536	0.683	0.340	0.340	0.776	0.433
14000	0.181	0.155	1.056	0.668	0.608	0.336	0.518	0.181	0.336	0.294	1.512	0.668	0.336	0.336	0.762	0.427
14500	0.178	0.152	1.038	0.660	0.600	0.330	0.509	0.178	0.330	0.288	1.485	0.660	0.330	0.330	0.750	0.419
15000	0.176	0.147	1.019	0.649	0.588	0.323	0.502	0.176	0.323	0.283	1.461	0.649	0.323	0.323	0.736	0.412
15500	0.173	0.143	1.003	0.635	0.579	0.318	0.492	0.173	0.318	0.278	1.437	0.635	0.318	0.318	0.721	0.404
16000	0.173	0.140	0.983	0.627	0.568	0.311	0.481	0.173	0.311	0.273	1.411	0.627	0.311	0.311	0.713	0.397
16500	0.168	0.140	0.968	0.613	0.561	0.308	0.478	0.168	0.308	0.269	1.388	0.613	0.308	0.308	0.699	0.393
17000	0.165	0.137	0.951	0.605	0.553	0.303	0.469	0.165	0.303	0.263	1.369	0.605	0.303	0.303	0.686	0.384
17500	0.164	0.134	0.935	0.593	0.543	0.298	0.461	0.164	0.298	0.260	1.344	0.593	0.298	0.298	0.675	0.378
18000	0.161	0.131	0.924	0.584	0.534	0.292	0.452	0.161	0.292	0.257	1.324	0.584	0.292	0.292	0.663	0.373

Table 8.6

Average Annual Ground Level Concentrations of SPM in 16 Wind Directions from the Proposed Power Plant at Neyveli (250 MW Lignite based)

Distance (metres)	Concentration (microgram/m ^ 3)															
	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE	N	NNW	NW	WNW
500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1000	0.002	0.007	0.030	0.017	0.011	0.008	0.010	0.002	0.008	0.012	0.035	0.017	0.008	0.008	0.018	0.009
1500	0.011	0.009	0.069	0.042	0.036	0.020	0.031	0.011	0.020	0.022	0.097	0.042	0.020	0.020	0.047	0.025
2000	0.007	0.009	0.062	0.034	0.027	0.016	0.023	0.007	0.016	0.025	0.081	0.034	0.016	0.016	0.038	0.020
2500	0.004	0.012	0.080	0.033	0.022	0.018	0.020	0.004	0.016	0.027	0.070	0.033	0.016	0.016	0.034	0.018
3000	0.004	0.013	0.082	0.034	0.021	0.015	0.019	0.004	0.015	0.029	0.070	0.034	0.015	0.015	0.035	0.018
3500	0.006	0.016	0.073	0.040	0.028	0.020	0.026	0.006	0.020	0.030	0.085	0.040	0.020	0.020	0.043	0.023
4000	0.007	0.016	0.086	0.048	0.037	0.025	0.032	0.007	0.025	0.033	0.106	0.048	0.025	0.025	0.053	0.028
4500	0.011	0.018	0.098	0.057	0.046	0.028	0.041	0.011	0.028	0.035	0.126	0.057	0.028	0.028	0.063	0.035
5000	0.012	0.019	0.107	0.064	0.051	0.032	0.044	0.012	0.032	0.037	0.140	0.064	0.032	0.032	0.070	0.038
5500	0.014	0.018	0.110	0.067	0.058	0.034	0.050	0.014	0.034	0.035	0.148	0.067	0.034	0.034	0.075	0.042
6000	0.016	0.019	0.113	0.070	0.059	0.035	0.051	0.016	0.035	0.035	0.151	0.070	0.035	0.035	0.078	0.043
6500	0.016	0.019	0.112	0.070	0.058	0.035	0.051	0.016	0.035	0.036	0.154	0.070	0.035	0.035	0.076	0.043
7000	0.016	0.019	0.110	0.070	0.058	0.033	0.051	0.016	0.033	0.034	0.152	0.070	0.033	0.033	0.078	0.043
7500	0.018	0.017	0.108	0.066	0.058	0.035	0.049	0.018	0.035	0.032	0.148	0.066	0.035	0.035	0.076	0.041
8000	0.016	0.017	0.105	0.066	0.056	0.033	0.049	0.016	0.033	0.032	0.146	0.066	0.033	0.033	0.076	0.042
8500	0.016	0.015	0.103	0.064	0.057	0.031	0.049	0.016	0.031	0.030	0.142	0.064	0.031	0.031	0.072	0.041
9000	0.017	0.015	0.100	0.064	0.055	0.032	0.047	0.017	0.032	0.028	0.140	0.064	0.032	0.032	0.070	0.041
9500	0.015	0.015	0.097	0.062	0.055	0.032	0.047	0.015	0.032	0.029	0.139	0.062	0.032	0.032	0.070	0.039
10000	0.015	0.013	0.096	0.061	0.053	0.030	0.045	0.015	0.030	0.027	0.134	0.061	0.030	0.030	0.069	0.037
10500	0.014	0.013	0.094	0.059	0.054	0.030	0.046	0.014	0.030	0.026	0.130	0.059	0.030	0.030	0.067	0.037
11000	0.016	0.014	0.091	0.059	0.051	0.029	0.044	0.016	0.029	0.028	0.129	0.059	0.029	0.029	0.066	0.035
11500	0.016	0.012	0.089	0.056	0.049	0.027	0.044	0.016	0.027	0.023	0.126	0.056	0.027	0.027	0.066	0.036
12000	0.014	0.012	0.091	0.054	0.050	0.028	0.042	0.014	0.028	0.023	0.127	0.054	0.028	0.028	0.063	0.036
12500	0.014	0.012	0.087	0.054	0.049	0.027	0.041	0.014	0.027	0.023	0.126	0.054	0.027	0.027	0.061	0.034
13000	0.014	0.012	0.086	0.053	0.049	0.027	0.043	0.014	0.027	0.023	0.123	0.053	0.027	0.027	0.059	0.034
13500	0.014	0.012	0.083	0.053	0.047	0.025	0.041	0.014	0.025	0.025	0.119	0.053	0.025	0.025	0.059	0.033
14000	0.013	0.010	0.081	0.052	0.045	0.025	0.040	0.013	0.025	0.025	0.118	0.052	0.025	0.025	0.059	0.033
14500	0.013	0.010	0.080	0.050	0.046	0.026	0.040	0.013	0.026	0.023	0.115	0.050	0.026	0.026	0.059	0.031
15000	0.013	0.010	0.078	0.050	0.045	0.024	0.038	0.013	0.024	0.023	0.114	0.050	0.024	0.024	0.057	0.031
15500	0.013	0.010	0.077	0.049	0.043	0.023	0.039	0.013	0.023	0.023	0.109	0.049	0.023	0.023	0.054	0.030
16000	0.013	0.010	0.076	0.047	0.043	0.023	0.037	0.013	0.023	0.023	0.109	0.047	0.023	0.023	0.054	0.030
16500	0.013	0.010	0.076	0.048	0.041	0.022	0.037	0.013	0.022	0.021	0.107	0.048	0.022	0.022	0.052	0.030
17000	0.011	0.010	0.073	0.044	0.041	0.022	0.037	0.011	0.022	0.021	0.106	0.044	0.022	0.022	0.053	0.028
17500	0.011	0.011	0.072	0.044	0.041	0.023	0.034	0.011	0.023	0.021	0.103	0.044	0.023	0.023	0.051	0.029
18000	0.011	0.011	0.072	0.045	0.041	0.023	0.034	0.011	0.023	0.021	0.102	0.045	0.023	0.023	0.052	0.029

Table 8.7

NEYVELI LIGNITE POWER STATION

Comparison of predicted annual SO2 concentrations with World Bank limits (unit: $\mu g/m^3$)

	Sampling sites				
	Melakuppa	**Umangalam**	**Arasakuzhi**	**Edakkupam**	**Uthangal**
Average existing levels (*)	4.6	3.4	2.4	3.7	2.6
Power station contributio	2.4	2.4	2.4	2.4	2.4
Total predicted backgroun	7.0	5.8	4.8	6.1	5.0
% of World Bank's limit	7.0	5.8	4.8	6.1	5.0

Note: (i) World Bank limit for SO2 is $100 \mu g/m^3$
(ii) (*) Figures based on 8hr values monitored over 1 month period

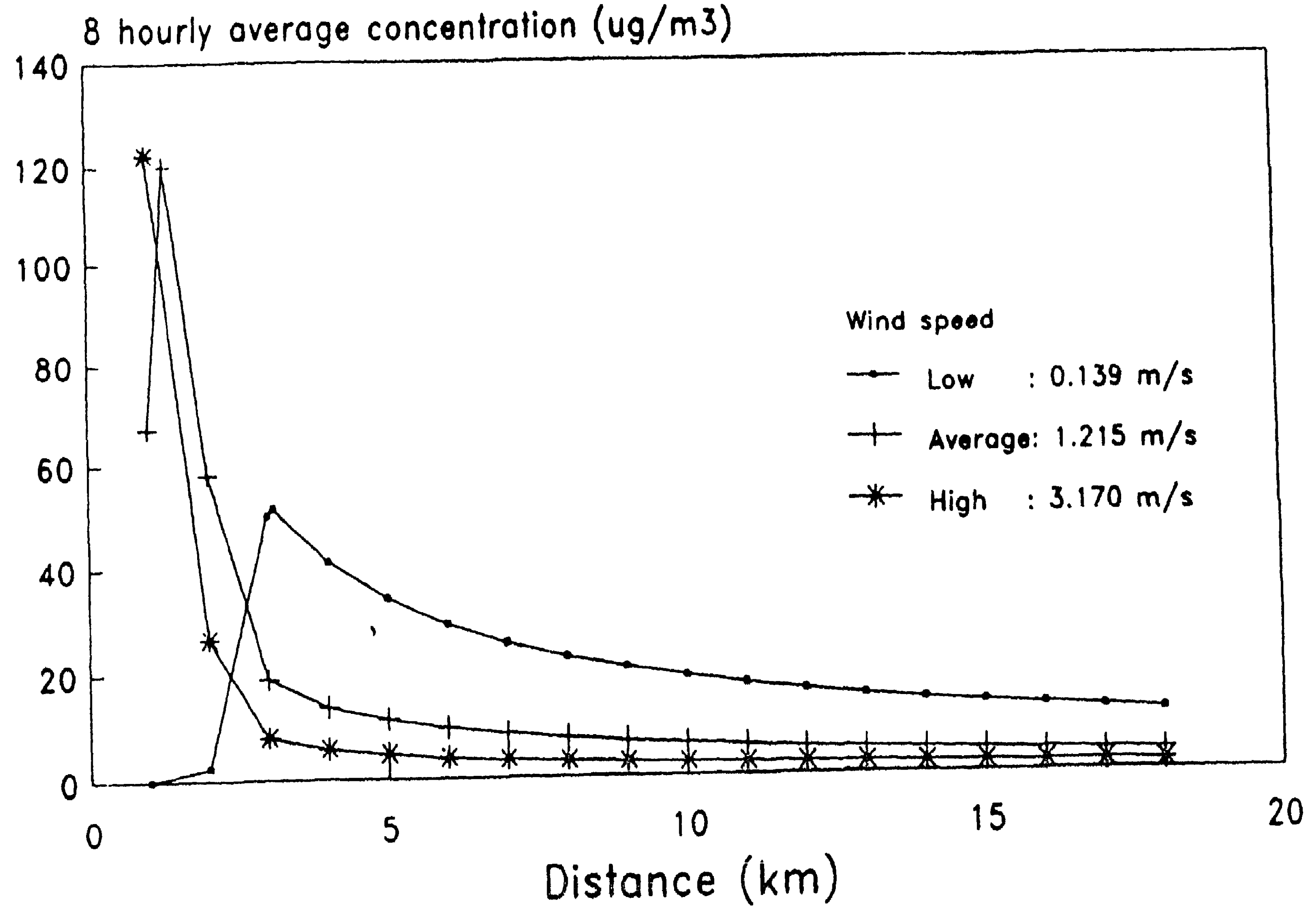
Table 8.8

NEYVELI LIGNITE POWER STATION

Comparison of predicted annual NO2 concentrations with World Bank limits (unit: $\mu g/m^3$)

	Sampling sites			
	Arasakuzhi	**Mudhani**	**Card**	**Umangalam**
Average existing levels (*)	8.2	11.6	9.6	9.2
Power station contributio	2.0	2.0	2.0	2.0
Total predicted backgroun	10.2	13.6	11.6	11.2
% of World Bank's limit	10.2	13.6	11.6	11.2

Note: (i) World Bank limit for NO2 is $100 \mu g/m^3$
(ii) (*) Figures based on 2 months monitoring data using diffusion tubes



Short term SO2 concentrations
Neyveli TPS – Zero unit
Atmospheric Stability: Very Unstable

Figure 8.1

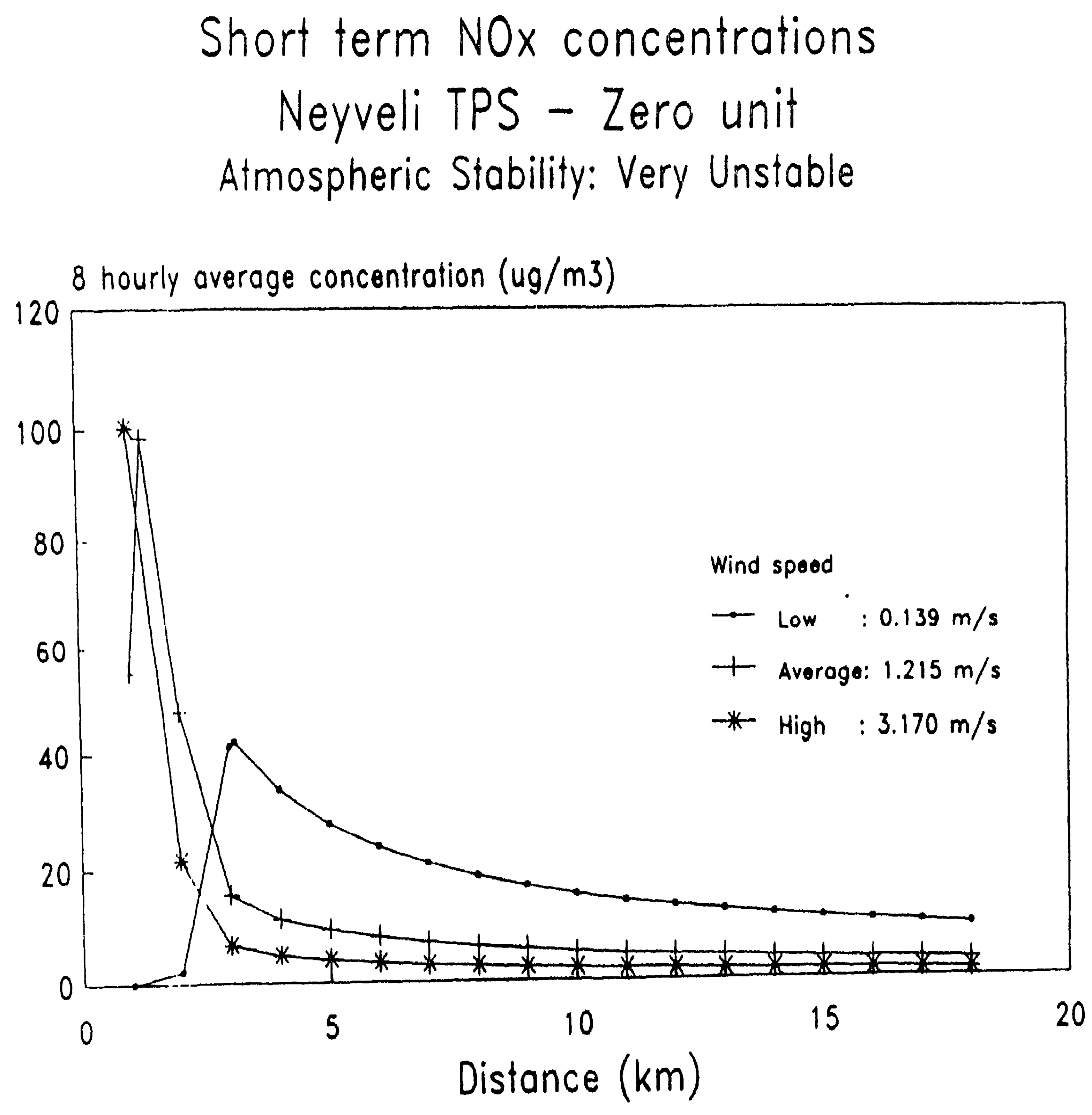

Short term NOx concentrations
Neyveli TPS - Zero unit
Atmospheric Stability: Very Unstable
8 hourly average concentration (ug/m3)
120
100
80
60
40
20
0
0
5
10
15
20
Distance (km)
Wind speed
Low : 0.139 m/s
Average: 1.215 m/s
High : 3.170 m/s

Figure 8.2

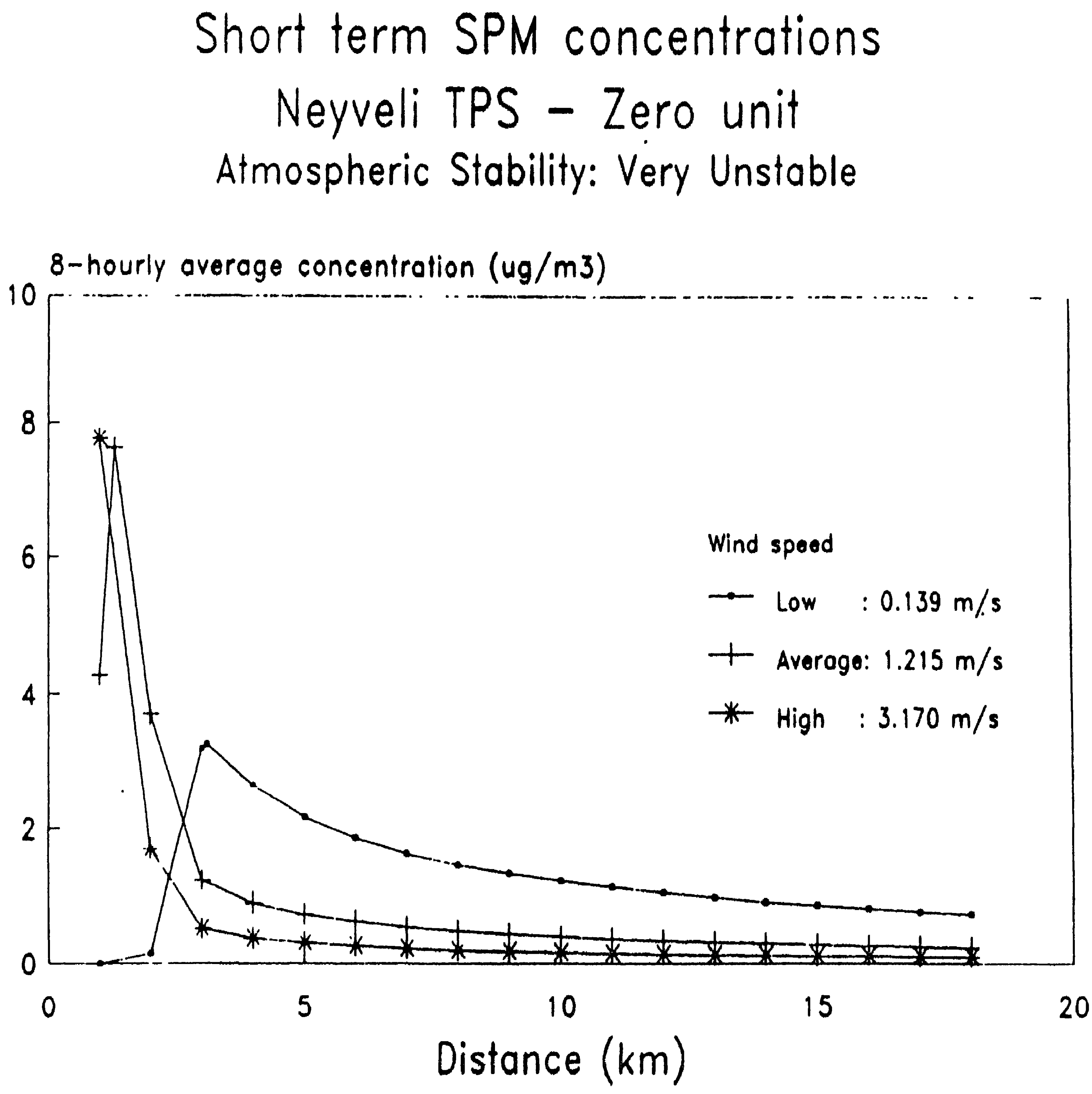

Short term SPM concentrations
Neyveli TPS - Zero unit
Atmospheric Stability: Very Unstable
8-hourly average concentration (ug/m3)
10
8
6
4
2
0
0
5
10
15
20
Distance (km)
Wind speed
Low : 0.139 m/s
Average: 1.215 m/s
High : 3.170 m/s

Figure 8.3

SECTION 9

ENVIRONMENTAL MANAGEMENT PLAN

SECTION 9

ENVIRONMENTAL MANAGEMENT PLAN

9.1 SCOPE OF PLAN

The main aim of the site environmental management plan will be used to ensure that the proposed Neyveli power station is operated with the minimum environmental impact. Hence, systems will be installed to ensure that the feedstocks, i.e. fuel and water, are properly controlled and that all releases to the environment are determined. These will be developed in more detail in Section 10 which describes the monitoring plan.

In addition to determining the releases to the environment there are also a number of other aspects that needs to be included in the environmental management plan to make it effective. These are:-

- Work plans and schedule
- Implementation and resources
- Emergency procedures
- Training.

9.2 WORK PLANS AND SCHEDULES

9.2.1 Fuel Management

9.2.1.1 Lignite

Lignite transport, handling and storage will be carried out in a controlled manner ensuring that any nuisance is confined to specific areas allocated for those purposes.

Transport of lignite to site is expected to be by conveyor and will, as far as possible. minimise dust nuisance by enclosing the conveyor, with damping if required. Any on site lignite storage will be in an allocated area and damping used if dust nuisance becomes a problem.

Where lignite is delivered by road or rail appropriate steps will be taken to minimise noise and dust nuisance locally.

9.2.1.2 Oil

The possibility exists of fuel oil spillage during unloading of the delivery tankers and oil absorbed granules should be available at the power station. Staff trained in their use should be on duty throughout oil unloading.

All fuel oil and lubricating oil storage tanks should be bunded, with bunds sized to hold 110% of the relevant tank contents and no unvalved drains from these bunds should be installed. All valved drains should be fitted with locks and only authorised persons should be key holders. The transformers should be located in bunds capable of containing the total oil content of the transformer.

9.2.2 Water Management

9.2.2.1 Cooling Water

The use of water will be minimised and appropriate water treatment used to ensure that biological growth is controlled, i.e. algae and legionella. The addition of any biocides or other chemicals such as corrosion inhibitors will be selected, and their use minimised, so as to have no harmful effect on the local water course.

9.2.2.2 Surface Water

Site management will ensure that the potential for pollution via the site drainage is minimised. This will require the correct labelling of drains, operator training, monitoring of effluent and, where the risk of oil or ash contamination is high, some form of separation system installed and managed.

9.2.3 Ash Management

The ash mound will be controlled so as to minimise dust nuisance and the leachate treated to minimise the suspended solids and heavy metals that run in to the local water course. This will probably require at least a settling tank and some monitoring of the effluent, see Section 10.

Where possible, opportunities for the sale of the ash as a useful by-product will be pursued.

9.2.4 Emissions Monitoring

From the start of the operation of Neyveli Lignite Power Station the stack emissions will be monitored to ensure that the appropriate limits are being adhered to. Typically this would be achieved by means of a monthly reporting schedule of emission concentration and tonnage releases for SO_2, NOx and particulates, see Section 10.

9.2.5 Maintenance

The plant will be maintained to ensure that releases to the environment are minimised. Records should be kept to show where maintenance has been carried out. This would apply to a range of areas including combustion optimisation, fuel handling and monitoring equipment.

9.3 COMPENSATORY MEASURES AND EMERGENCIES

9.3.1 Compensatory Measures

Where any specific problem areas are identified with the station's environmental performance compensatory measures will be assessed and if deemed to be appropriate included in the future improvement plans for the station. This might arise through the deterioration of performance of parts of the plant, changes in legislation or changes in the lignite fuel over the station lifetime.

9.3.2 Emergencies

In the event of an emergency, the Environmental Officer will be available to provide specialist advice as to the environmental aspects of the situation and potential for pollution incidences. Advice would also be provided on use of fire equipment available at the site.

In order to provide 24 hour coverage, either a further member of staff will be appointed for those times not covered by the full-time officer, or provision will be made for the officer to be accessible 24 hours a day.

The power station will draw up an "Emergency Action Plan" to ensure that all plant personnel are aware of their responsibilities in case of an emergency. Fire protection equipment and facilities will be available at suitable locations within the power station and these would include:

(a) Fixed fire protection system
(b) Fire hydrants
(c) Alarm annunciator
(d) Portable fire fighting equipment
(e) Automatic fire vents
(f) Fire compartments and
(g) Fire exit signs

9.4 RESOURCES, IMPLEMENTATION AND TRAINING

9.4.1 Resources

The power station operational workforce will include a designated environmental officer and a senior manager with executive responsibility for environmental matters at Neyveli power station. This officer will be suitably trained and be responsible for the following:-

- ensuring that environmental protection procedures are followed
- co-ordinating environmental monitoring
- acting as a contact person for liaison with the public, local organisations and Government
- ensuring that data on all environmental aspects of plant operation is continuously updated, and available in a form suitable for immediate inspection by authorised personnel
- monitoring hazardous substances on site to ensure that the possibility of accidental release is minimised
- promoting on-site environmental awareness
- liaison with other local industry

9.4.2 Implementation

The environmental officer will be responsible for ensuring that the environmental management plan is effective. Where necessary the senior manager responsible for environmental matters may be required to instigate change to ensure the environmental standards outlined in this Environmental Assessment and any future Indian Legislation are adhered to.

9.4.3 Training

The designated environmental officer will be charged with an ongoing programme of environmental training. This will include:-

- general promotion of environmental awareness
- specific training for staff working in sensitive areas
- updating staff on changes to environmental standards
- reporting to staff on the station environmental performance.

9.5 SCOPE OF PLAN

In addition a technician will be required who has the responsibility for carrying out the environmental monitoring plan discussed in Section 10.

SECTION 10

ENVIRONMENTAL MONITORING PLAN

SECTION 10

ENVIRONMENTAL MONITORING PLAN

10.1 PARAMETERS TO BE MONITORED

This section considers a monitoring plan and management procedures for Neyveli Lignite Power Station to ensure that updated records of environmental parameters are maintained during the operation of the proposed power station. This will include fuel, air quality and emissions, water quality and ash disposal.

Monitoring of certain parameters during both the construction and operational phases of the power station is essential to ensure that impacts are evaluated and necessary mitigation measures are applied to ensure compliance with any current and future standards. We would anticipate that monitoring will apply to the following:

- fuel quality
- stack emissions
- water effluent
- noise
- ash.

10.2 TARGET MEDIA AND MONITORING SCHEDULES

10.2.1 Atmospheric Emissions

Computer models have been used to predict the expected atmospheric emissions from the power station once it is operating. The results of the modelling exercise indicate expected levels of atmospheric pollution in areas within and around the power station site.

Following commissioning of the power station, air pollution monitoring will be carried out to measure SO_2 and NOx and particulates at sites in the surrounding area to verify the pollution modelling results, and ensure that the levels specified in standard are being met. This will typically include at least three monitoring stations within the study area, including one at the expected point of maximum impact. Also, an additional monitoring station should be located within the station boundary.

Emission monitoring will also form part of the plant operation procedure. During operation, the emissions from each of the flues of the chimney will be monitored on a continuous basis. The flue gases will be analysed for NOx, SO_2 and particulate matter. These data will be recorded and monthly loss made of average concentrations as well as clculated tonnage releases of each pollutant.

These records will be maintained for at least 4 years.

10.2.2 Water

Waste water will be discharged from the following sources:

- cooling water system
- water treatment plant
- surface run off
- sewage treatment plant.

All effluents will be treated prior to discharge to minimise impurities and contamination. Any water discharged will be regularly tested on typically a monthly basis to check chemical and suspended solids content. These records will be kept for at least 4 years.

Any waste water which may contain oil will pass through an oil/water seperator with a manually operated control valve.

10.2.3 Noise

A noise survey both within operational areas and at the site boundary will be undertaken at regular intervals and not less than every 12 months and the results retained for at least 20 years.

Following commissioning of the power station, noise monitoring will be undertaken both within the site and at the site boundaries. The monitoring will verify whether the plant is operating to the levels specified. The monitoring results will also act as a valuable database of noise levels for different meteorological and station conditions, to assist in any subsequent design changes or increases in noise levels in the power station area.

10.2.4 Fuel

Regular fuel samples (typically monthly) will be analysed for; CV, C, H, N, O, S, Cl, H_2O and ash so that these can be used to calculate emissions from the power station and validate the stack monitoring. This may be made a requirement for the fuel suppliers for which only occasional cross checks (twice annually) would be by the plant operators.

Results will be retained for at least 4 years.

10.2.5 Ash

An annual ash sample will be collected and tested for heavy metal content (Hg, Cd, As, Cu, Cr, Sn, Fe, Mn). In addition the leachability of these elements in water and the resultant pH of the leachate will be determined for a 100 g sample of ash.

Records will be maintained for the previous 10 years.

10.3 RESOURCES AND IMPLEMENTATION

The Environmental Monitoring Plan will require the full time employment of a technician to analyse samples and report these to the environmental officer. The technician will be provided with on-site facilities for carrying out all the required chemical analyses necessary to produce the information outlined in Section 10.2 as well as maintaining the equipment necessary for monitoring.

It will be the responsibility of the environmental office to implement the site environmental management plan and encourage general site environmental awareness. There will also be a nominated senior manager with responsibility for environmental matters who can ensure that decisions can be made to rectify any problems for example, modifying plant operations where there is an exceedance of emission standards or simply where equipment needs repair or replacement.

There may be occasions where outside bodies are required for specialist monitoring or training. This may arise for example if there was a complex noise issue requiring detailed frequency analysis or if training was required in specific areas, such as ash leachate control.

SECTION 11

CONCLUSIONS

SECTION 11

CONCLUSIONS

The construction and operation of the Neyveli Power Station will have the following environmental and economic impact. The negative impacts will include:

- a slight increase in disturbance attributable to traffic during both the construction and operations phases the. The traffic will be diverted away from the residential areas.

- a small increase in baseline noise levels as a result of traffic, construction activities and normal plant operation. The noise of the site boundary will be kept below the World Bank guidelines.

- a slight deterioration in ambient air quality for SO_2 and NO_x but within World Bank Environmental Guidelines. A stack of 220 m height will be provided to disperse these pollutants.

- some level of disturbance of local ecology during both the construction and operations phases, but within acceptable levels.

However, the positive impacts include:

- the potential for long and short-term employment for local people;

- production of electricity for sustained growth in Tamur Nadu state;

- production of electricity for potential for export to other regions;

- an injection of capital into the local economy.

The proposed mitigatory measures, when implemented, will reduce the negative impacts on the environment to acceptable levels.

SECTION 12

LIST OF REFERENCES

SECTION 12

LIST OF REFERENCES

12.1 PUBLISHED REFERENCES

1. Environmental Guidelines, The World Bank, Washington, Sept. 1988.
2. The Management of Cultural Property in The World Bank, Technical Paper 62, Washington, 1987.
3. Occupational Health and Safety Guidelines, Office of the Environmental Affairs, World Bank, June 1984.

12.2 LIST OF MEETINGS

The following meetings were held, along with meeting venues.

1. Neyveli Lignite Corporation, Neyveli.
2. Centre for Applied Research and Development, Neyveli.
3. Ministry of Environment & Forests, New Delhi.
4. Central Electricity Authority, New Delhi.
5. Tamil Nadu Pollution Control Board, Madras.
6. International Finance Corporation, Brighton, UK.

12.3 OTHER RESOURCES

Discussions with a number of selected individuals working or residing in the Neyveli complex. A number of text books were consulted as well as reference to other existing and past relevant studies.

APPENDIX A

IFC'S TERMS OF REFERENCE FOR NEYVELI EIA

OUTLINE OF AN ENVIRONMENTAL ASSESSMENT REPORT[1]

EXECUTIVE SUMMARY

a) concise discussion of significant findings
b) recommended actions

POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

a) framework within which the EA is prepared
b) environmental requirements of the World Bank, of any cofinanciers, and of the country in which the project is located

PROJECT DESCRIPTION

a) site (or sites; including any installations or investments outside of the main project site)
b) project design and operation or function, including environmental protection measures
c) project construction plans
d) raw materials, intermediate products, final products, and wastes
e) releases to the environment and/or environmental alterations during construction (e.g.; land grading, right-of-way clearance, road building, etc.)
f) releases to the environment during operation or project life
g) project employment
h) project economic interaction with the surrounding community and region
f) costs of any alternative environmental protection measures

BASELINE DATA FOR THE PROJECT SITE AND AREA

a) dimensions of the study area
b) climate
c) topography, geology
d) soils
e) hydrology, hydrogeology
f) ecology, flora and fauna (including identification of unique ecologies or endangered/threatened species)

---

1. Source: World Bank Operational Directive: 4.01, Annex B.

g) socio-economic conditions
h) archeological/historical sites
i) current and proposed development activities not connected to the project

ENVIRONMENTAL IMPACT

a) positive and negative impacts of the construction and operation of the proposed project
b) mitigation measures and residual impacts that can not be mitigated
c) climate
d) soils
e) hydrology, hydrogeology, water quality
f) air quality
g) noise
h) ecology, flora and fauna
i) socio-economic conditions
j) archeological/historical sites
k) occupational health and safety

MITIGATION/ENVIRONMENTAL MANAGEMENT PLAN

a) description of feasible, cost-effective measures that may reduce significant environmental impacts to acceptable levels
b) residual impacts not mitigated by each measure
c) capital and recurrent costs
d) institutional and training requirements (i.e., development of capabilities needed to implement mitigatory measures)
e) work plans and schedules (to ensure actions are taken in phase with appropriate project engineering activities
d) compensatory measures where mitigatory measures are not feasible or cost-effective

MONITORING PLAN

a) parameters to be monitored
b) target media and areas
c) schedule
d) type of monitoring
e) identification of responsible parties, staffing requirements,
f) inputs required (e.g., training)
g) costs

REFERENCES

a) all information sources, including unpublished documents and sources

RECORD OF INFORMATION MEETING

a) list of meeting invitees
b) description of any other occasions where views of affected parties or non-government organizations (NGOs) were obtained

12/22/92
[illegible]

APPENDIX B

WORLD BANK GUIDELINES - OCCUPATIONAL HEALTH AND SAFETY

APPENDIX B

OCCUPATIONAL HEALTH AND SAFETY (WORLD BANK GUIDELINES)

B1 Safety

Steam pipes should be thermally insulated.

Shield guards and guard railings should be provided where belts, pulleys, shafting, gears or other moving parts are located.

All elevated platforms, walkways, stairways and ramps should be equipped with handrails, toeboard and non-slip surfaces.

Electrical equipment should be grounded and checked for defective insulation. All electrical installations and equipment should be in accordance with the standards of the National Electrical Code.

Workers responsible for cleaning boilers should be provided with special footwear, masks and dust-proof clothing.

Maintenance workers and cleaners who enter enclosed areas for cleaning fuel oil residues or coal ash dust must wear self contained respirators.

The cleaning of boilers may require the use of corrosive acids such as sulphuric acid and hydraulic acid, as well as caustic chemicals. The workers using these chemicals should wear protective clothing and goggles. Emergency eyewash and showers should be available in the working areas.

A programme for fire safety should be regularly carried out. This is important to establish a safety programme in case of fires due to flame out.

Good housekeeping practices should include: keeping all walkways clear of debris; cleaning up oil spots and excess water as soon as they are noticed; and regular inspection and maintenance of all machinery.

B2 Electrocution

Rigid procedures for de-energizing and checking the electrical equipment should be followed before any maintenance and repair work can begin. Should work have to be done on energized equipment, a supervisor should be present throughout the period of work and should make sure that all safety measures are taken to prevent any accidents. Revival techniques after electrocution should be part of any first aid course being taught to employees.

B3 Health

Good sanitary and washing facilities must be provided. Employees should be encouraged to wash before eating and a separate lunchroom should be provided outside the work area.

These measures will help to reduce the incidence of dermatitis among employees.

B4 Temperature and Humidity

General ventilation in the boiler room will help reduce the likelihood of boiler room workers suffering from heat stress. It is often necessary to allow boiler room workers some time away from these areas in order to reduce and control heat stress.

B5 Noise

The noise levels around the generators or other equipment should be lower than 90dB(A); if this is not possible, those working near the equipment should have an insulated room where the noise level is below 75dB(A) and they should be supplied with ear protection to be worn when working the equipment. A worker could stay in the noise insulated room from which he can monitor the equipment through a window or by remote control. Good maintenance of equipment can help to reduce noise. Generators must be designed to meet noise level standards.

B6 Dermatitis

Encourage employees to wash up regularly and supply protection creams.

B7 Toxic Gases

Internal air should be monitored for SO_2 and NOx. The Threshold Limit Values (TLV) for these gases are as follows:

- SO_2 5 ppm (13 mg/m^3)
- CO 50 ppm (55 mg/m^3)
- NOx 5 ppm (9 mg/m^3)

Proper servicing and maintenance of the boilers will usually control the problem of leakage.

B8 Dust

Boiler areas should be monitored for dust, which arises from oil residues. Nuisance dust levels should not be allowed to exceed 10 mg/m^3 or 30 mppcf (million particles per cubic foot). Continued excessive dust must be controlled with exhaust ventilation and dust collection equipment. Dust masks should be made available if dust control equipment breaks down.

B9 Working in a Confined Space

Tanks containing fuel oil residues can have high levels of gases which can be a fire and explosion hazard. The air should be checked for high levels of gases, and excess gases should be exhausted before cleaning. Closed spaces may also be short of oxygen or contain toxic fumes or gases. Workers entering the tank must wear protective clothing and a respirator that receives outside air through a supply hose; a stand-by man should be stationed outside the tank to watch over the safety of the person inside the tank. Lights necessary to work in the closed metal tanks should be fed with 6-12 volt power to decrease the chances of electrocution.

B10 Medical Examination

Pre-employment and periodic medical examinations of all workers should be required.

B11 Training

The education and training of employees in good safety practices is the responsibility of management. Employees should be instructed in: proper use of all equipment operated; safe lifting practices; location and handling of fire extinguishers; and the use of personal protective equipment.

B12 Record Keeping

Management is required to keep records of all accidents and illnesses which have involved the employees in the plant.

Should the World Bank guidelines on Health and Safety be adopted, this information should be made available to the World Bank so that the World Bank Health and Safety programme may be evaluated.

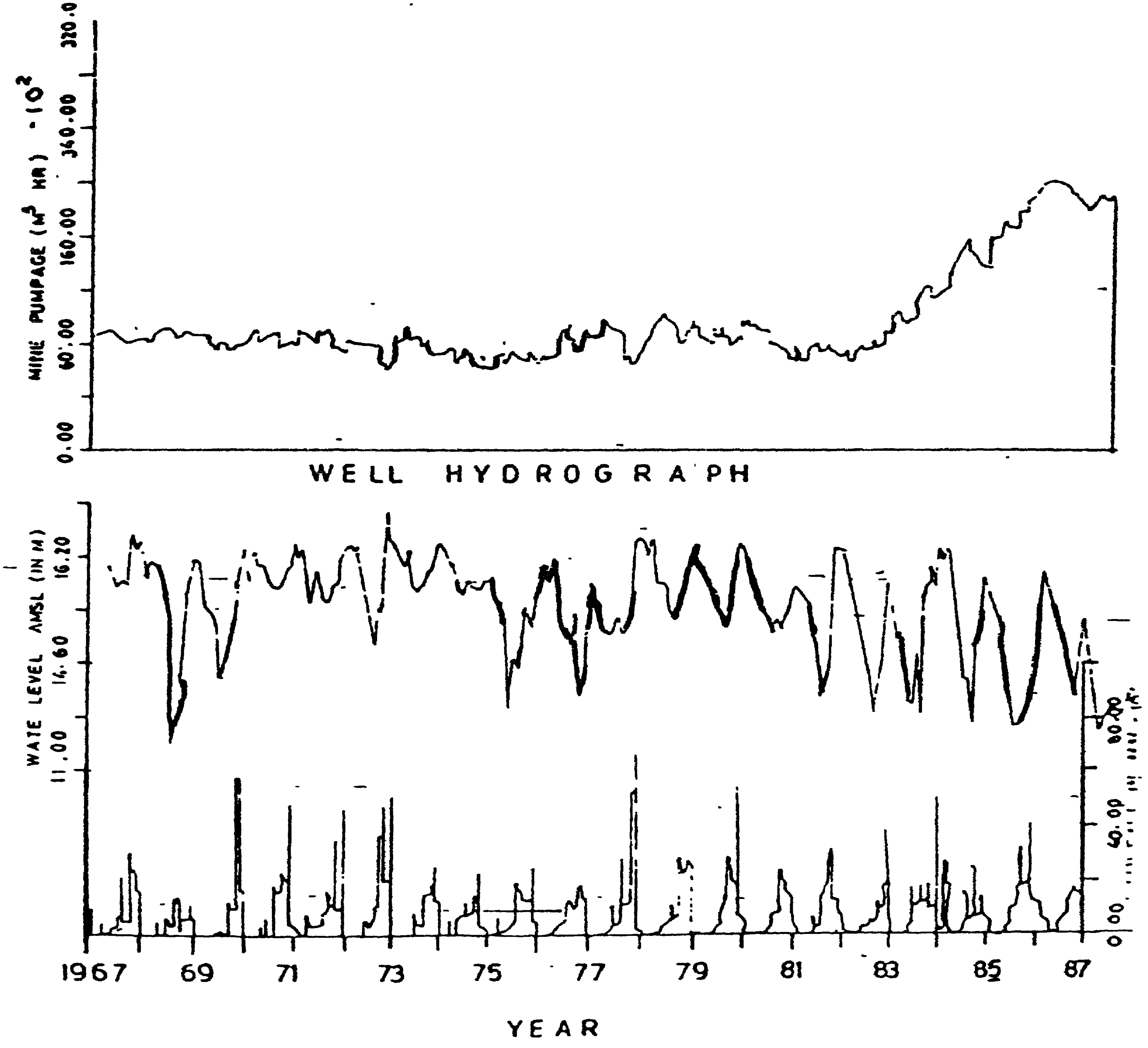
APPENDIX C

HYDROGRAPHS WITH GROUNDWATER CONTOURS

REGIONAL GROUNDWATER MODELING. NEYVELI BASIN

WELL HYDROGRAPH AT KANUR
IN RELATION WITH RAINFALL AND MINE PUMPAGE

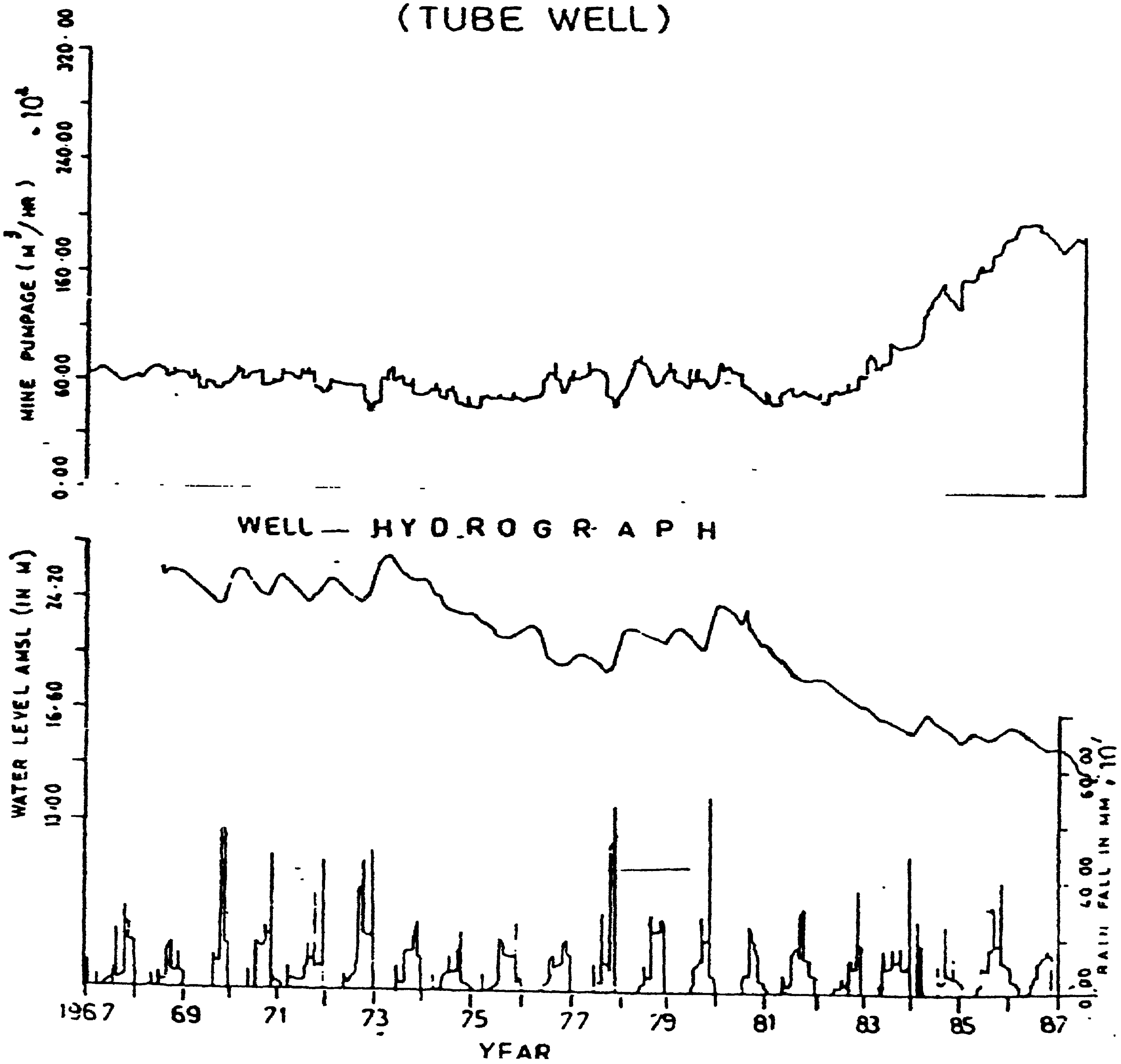
(DUG WELL)



REGIONAL GROUNDWATER MODELING, NEYVELI BASIN

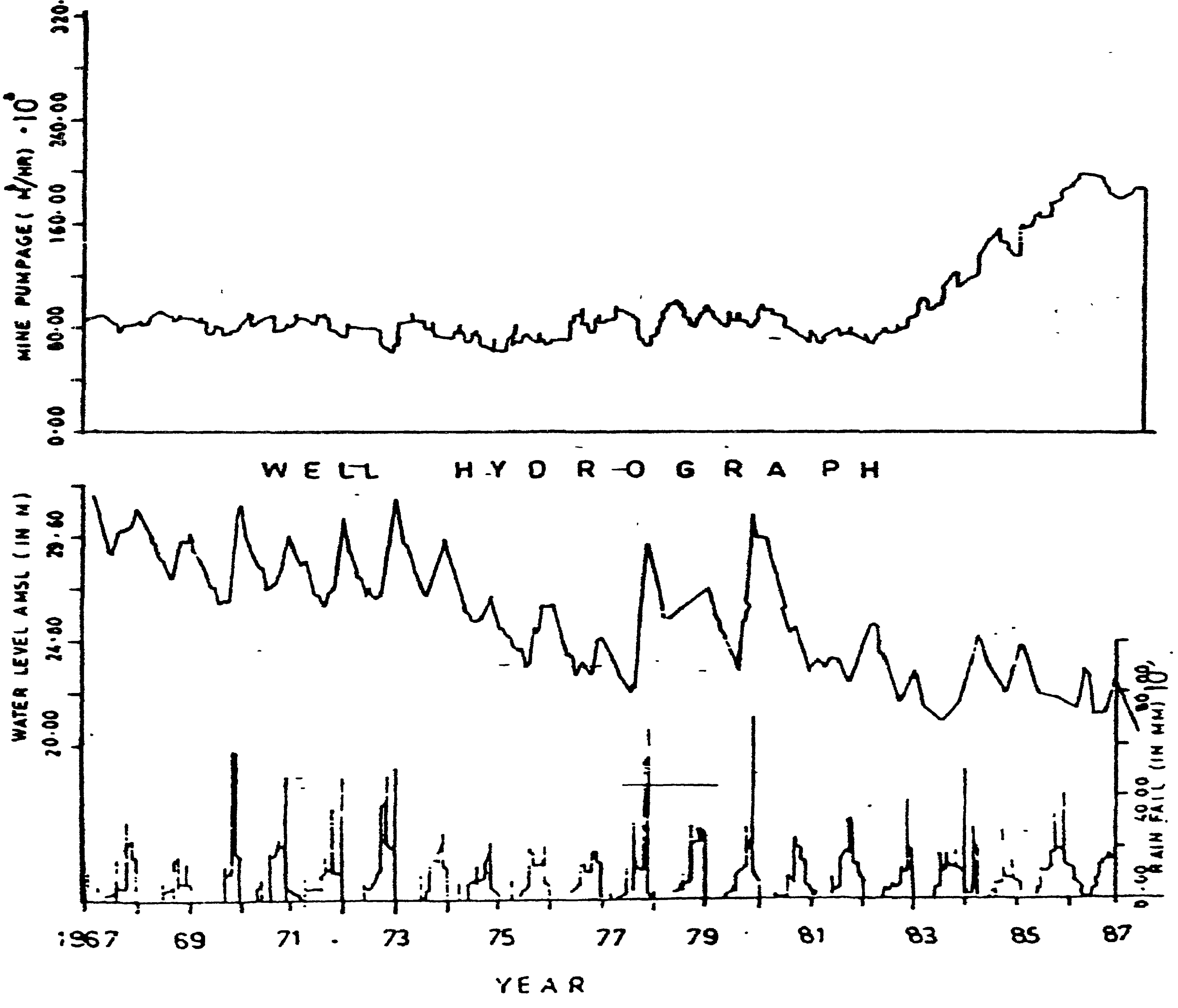
WELL HYDROGRAPH AT KADAMPULIYUR
IN RELATION WITH RAINFALL AND MINE PUMPAGE

(TUBE WELL)



REGIONAL GROUNDWATER MODELING NEYVELI BASIN

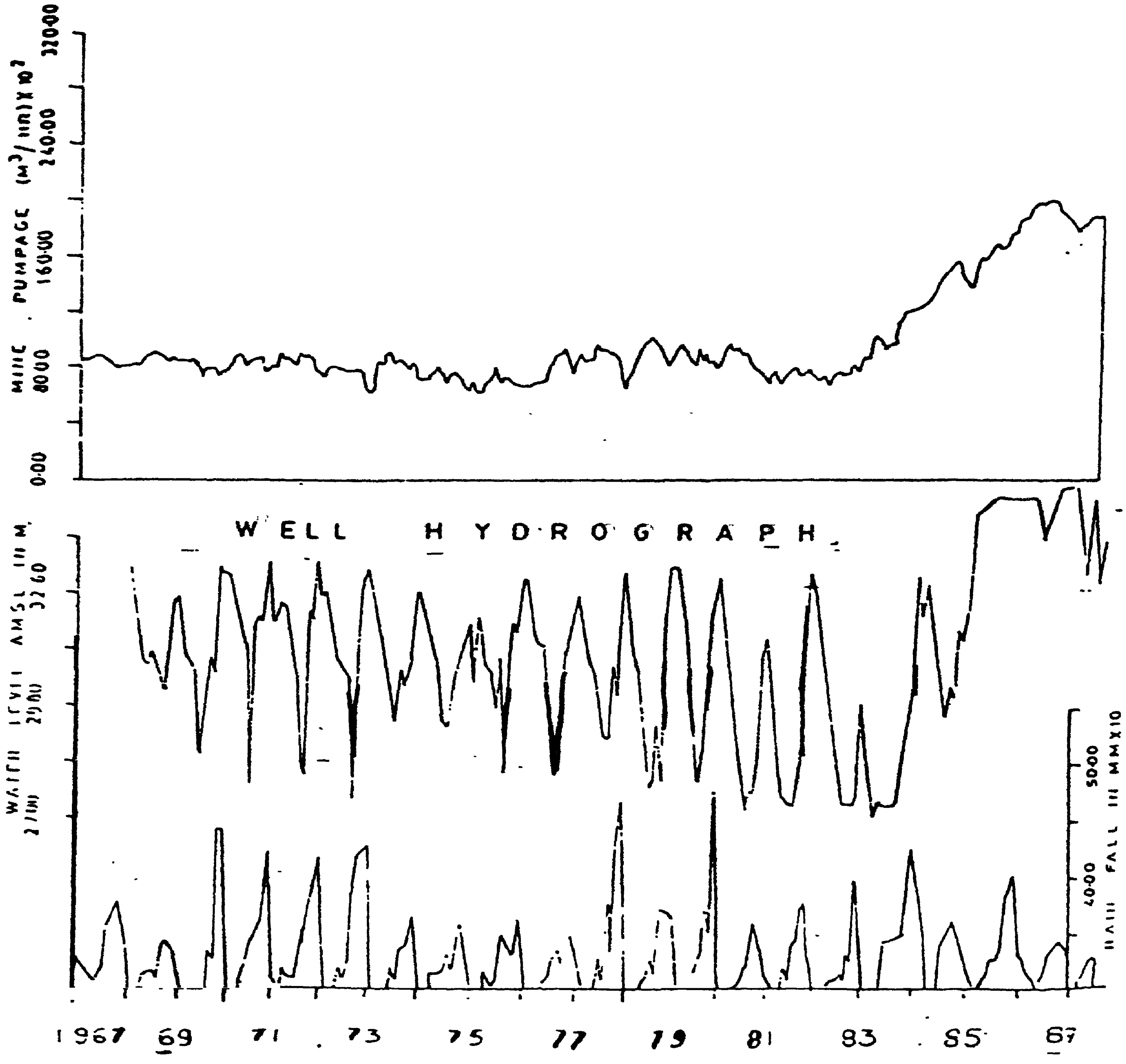
WELL HYDROGRAPH AT BUDHAMUR
IN RELATION WITH RAINFALL AND MINE PUMPAGE
(TUBE WELL)



REGIONAL GROUNDWATER MODELING, NEYVELI BASIN

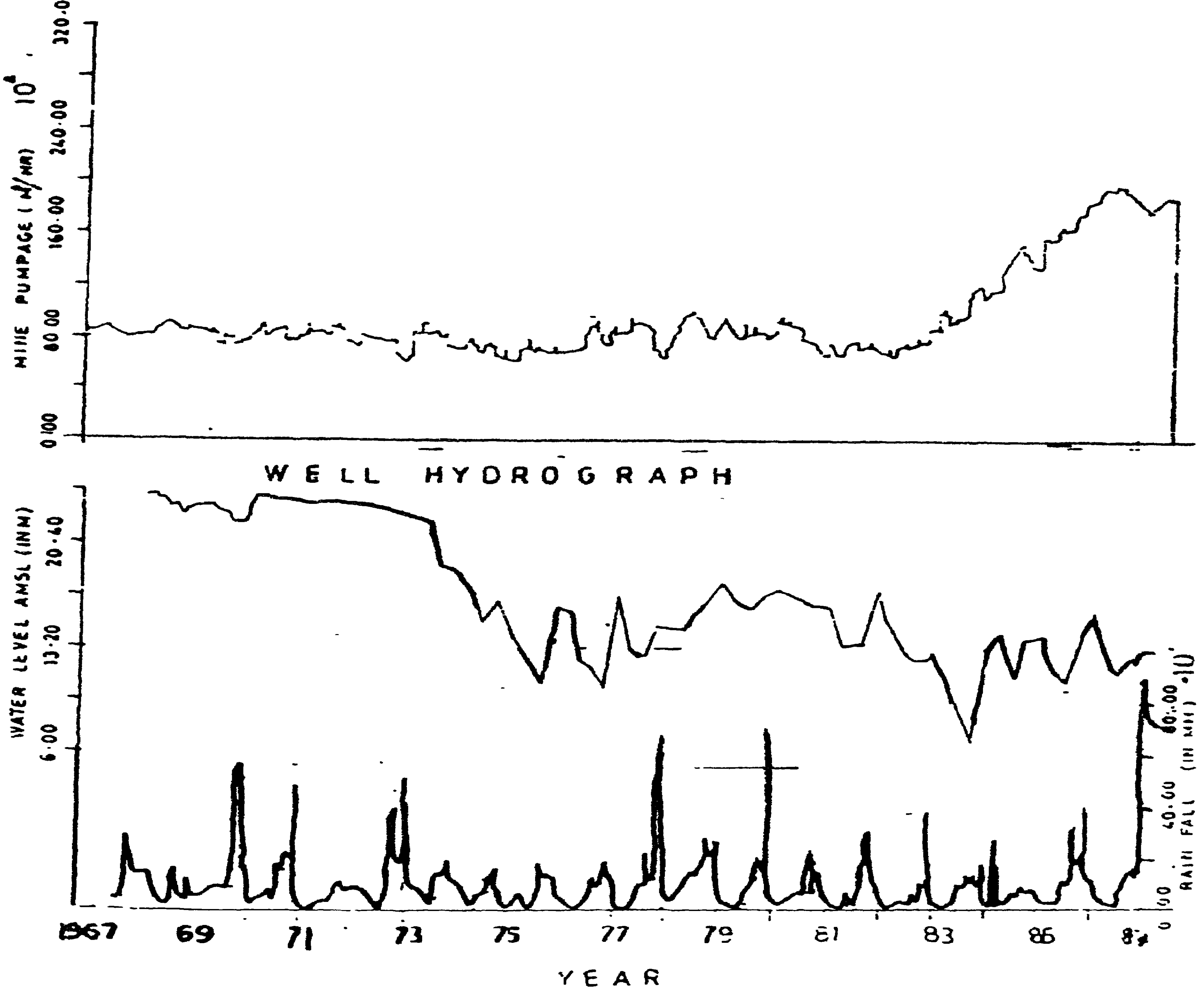
WELL HYDROGRAPH AT VADALUR

IN RELATION WITH RAINFALL AND MINE PUMPAGE (DUG WELL)



REGIONAL GROUNDWATER MODELING NEYVELI BASIN

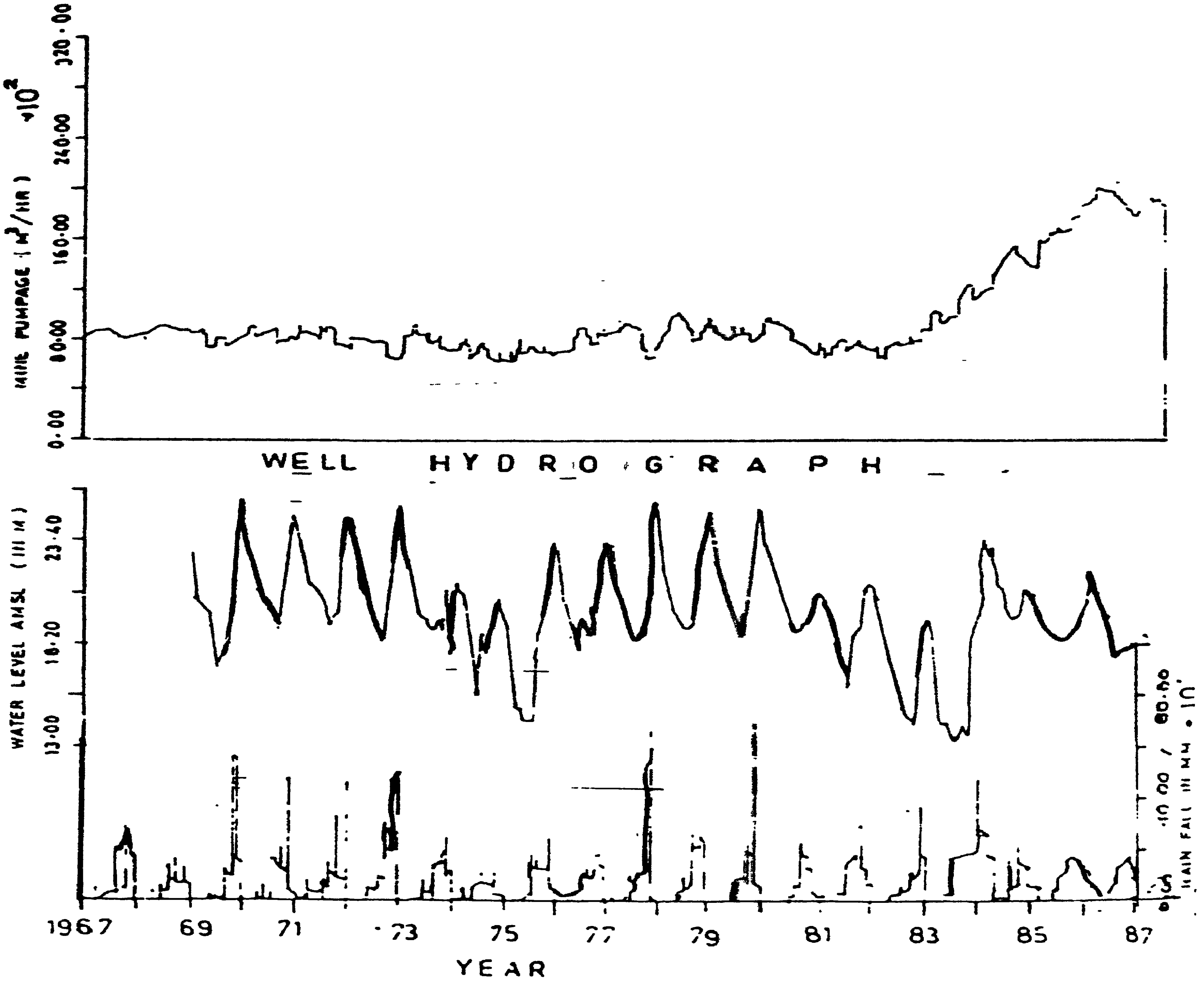
WALL HYDROGRAPH AT THAMBIPETTAILAYAM IN RELATION WITH RAINFALL AND MINE PUMPAGE (TUBE WELL)



REGIONAL GROUNDWATER MODELING NEYVELI BASIN

WELL HYDROGRAPH AT NADUVEERAPATTU IN RELATION WITH RAINFALL AND MINE PUMPAGE

(DUG WELL)



APPENDIX D

LIST OF PLANTS RECORDED FROM THE PROJECT AREA

List of plants recorded from the project area

Following are the major flora species which are native to Neyveli region.

1 Albizzia lebbeck
2. Albizzia amara
3. Albizzia odoratissima
4. Acacia leucophloea
5. Acacia ferruginia
6. Acacia chundra
7. Acacia pennata
8. Acacia sinuata
9. Azaidiricta indica
10. Ziziphus xylopyros
11. Ziziphus Mauritiana
12. Canthium dicoccum
13. Randia dumetorum
14. Carissa carandus
15. Cassia fistula
16. Pterolobium indicum
17. Todalia asiatica
18 Dodonia viscosa
19. Heteropogon contortus
20. Chloroxylon sweitenia
22 Murraya koenigi
22 Cassia ariculata
23 Diospyros montana
24 Gmelina asiatica
25 Opuntia dillenii
26 Cissus quadrangularis
27 Asparagus sp
28. Jatropha glandulifera
29. Thespicia populnea
30. Crotalaria juncea
31. Cassine glauca
32. Datura metal
33 Ipomea aquatica
34. Atlantia monophilla
35. Croton bonplandianum
36. Mimosa pudica
37. Calotropis gigantia
38. Tridax produmbens
39 Solanum torvum
40 Ficus benghalensis
41 Ficus virense
42. Ziziphus oenophlea
43 Bridelia retusa
44. Phoenix sp
45. Jasminum sp
46. Cyperus rotandus
47. Argeria cuneata
48. Themeda sp
49 Cocos nucifera
50 Tamarindus indica
51 Statitarchita indica
52 Prosopis juniflora
53. Pongamia pinnata (Derris indica)
54 Asparagus racemosus
55 Hemidesmus indica
56 Strycnos sp
57 Barlena buxifolia
58. Acacia nilotica
59. Acacia arabica
60. Terminalia alata
61. Wrightia tinctoria
62 Givotia rotalariformis

Following are the plants which are not native but introduced and are recent in origin

1. Eucalyptus hybrida
2. Eucalyptus citriodora
3. Peltoforum ferruginae
4. Samania saman
5. Acacia auruculiformis
6. Casurina equisitifolia
7. Ceiba pentandra
8. Dalbergia sissoo
9. Delonix regia
10. Dendrocalamus strictus
11. Grevelia robusta
12. Syzigium cumini
13. Lagerstroemia flosreginae
14. Leucana leucocephala
15. Polyathia longifolia
16. Melia dubia
17. Parkinsonia longifolia
18. Sesbania grandiflora
19. Tectona grandis
20. Terminalia arjuna
21. Agave mexicana
22. Acacia catechu
23. Anacardium occidentale
24. Spathodia companulata

APPENDIX E

LIST OF ANIMALS RECORDED IN THE PROJECT AREA

List of animals recorded from the project area

Following are the major fauna species which are native to Neyveli region

Reptiles and mammals (* indicate indirect record or enquiries from the local people)

1. Bonnet macaque (Macaca radiata)
2. Jackal*
3. Sloth bear*
4. Otter
5. Bat
6. Mongoose*
7. Civet cat*
8. Indian Pangolin*
9. Black naped hare*
10. Bandicoot
11. Monitor Lizard*
12. Common Lizard
13. Cobra
14 Python*

Birds

1. Large grey babbler
2. Red vented bulbul
3. Indian robin
4 Magpie robin
5. Common crow
6. Jungle crow
7. Black drongo
8 Tailor bird
9 Brahminy myna
10 Common myna
11 Indian house sparrow
12 Grey wagtail
13. Yellow wagtail
14 Purple sunbird
15. Green bee eater
16. White breasted kingfisher
17. Pied kingfisher
18. Hoopoe
19. House swift
20. Wire tailed swallow
21. Indian nigh jar
22 Koel
23. Crow peasant
24. King vulture
25 Scavenger vulture
26 Brahmini kite
27 Common pariah kite
28 Black winged kite
29 Spotted dove
30 Grey jungle fowl
31. Grey patridge
32 Little egret
33. Pond heron
34. Hawk eagle

APPENDIX F

TERI'S MODEL OF AIR QUALITY
TERIMAQ VERSION 1.0

APPENDIX F

TERI'S MODEL - TERIMAQ VERSION 1.0

The problem of air pollution can be viewed within different spatial and temporal scales. The spatial scale includes both the horizontal and vertical dimensions. Horizontal scale refers to the extent of the earth's surface covered, e.g. local, urban, regional, inter-continental or global. Vertical dimension implies the depth of the atmosphere involved in pollution. The time scale refers to the time over which the pollution problem evolves and the time over which its control needs to be resolved in order to minimise damage.

Air quality standards usually incorporate the effects of spatial and temporal scales at the air pollution problem. Thus as stated earlier, the standards are prescribed differently for different locations for each pollutant with concentration specified over distinct averaging times.

An Air Quality Module (AQM) can be defined as:

> "a quantitative method based on physical principles, for estimating pollutant concentration in a specific area and a period of time."

AQMs are usually distinguished by the type of source, pollutant transformation and removal mechanisms for the pollutant, distance of transport, and averaging time periods. The validity of the models depend upon the model assumptions and the quality of the input data. AQMs are useful for assessing the potential air pollution impacts and suggest alternatives based on whether the model estimates satisfy the regulatory standards of air quality.

TERI Models of Air Quality TERIMAQ Version 1.0 consists of three simple Gaussian Plume Models (GPMs)

i) Point source model
ii) Line source model
iii) Area source model

to simulate the atmospheric dispersion of pollutants. Amongst all models which are available, the Gaussian Point Source Dispersion Model (GPM) is chosen as this is found to be most suitable from the point of view of data availability and accuracy required. GPMs assume that the time averaged concentration of the pollutant in the vertical and the crosswind directions are normally distributed where the standard deviation of concentration in the two directions are empirically related to the level of turbulence in the atmosphere. The models further assume steady state conditions, ideal gas behaviour, continuous emission rates, homogeneous horizontal wind field, representative mean wind velocity and absence of directional wind shear in the vertical plane. The pollutant concentrations are assumed to be proportional to the emission rate of the source and their dilution inversely proportional to the wind speed. The models do not incorporate any physical and chemical transformation or removal mechanisms for the pollutants. The models also assume a uniform terrain and total reflection of the plume at the surface of the earth.

The Gaussian equation used in the TERIMAQ for the estimation of concentration due to pint source emissions is based on a co-ordinate system where the origin is at the , 'x' represents downwind from the source, 'y' represents crosswind from the source and z represents the vertical direction. The normal vertical distribution near the source is modified at grater distances by eddy reflection at the ground and, when the mixing height is low, by eddy reflections at the mixing height. For stable or unlimited mixing conditions, the GPM is given by:

$$c = \frac{Q\, g_1\, g_2}{u\, (2\pi)^{1/2}\, \sigma_y\, (2\pi)^{1/2}\, \sigma} \qquad (1)$$

For unstable or neutral conditions, GPM is defined for H (the effective stack height) and z (the height of the receptor, less than L (the mixing height). When σ_z is greater than 1.6 times of L, the GPM is given by:

$$c = \frac{Q\, g_1}{u\, (2\pi)^{1/2}\, \sigma_y\, L} \qquad (2)$$

For these large values of σ_z, eddy reflection occurs repeatedly both at the ground and at the mixing height, so that the vertical expanse of the plume is mixed uniformly throughout the mixing height.

For unstable or neutral conditions when σ_z is less than 1.6 times of L, the GPM is given by:

$$c = \frac{Q\, g_1\, g_3}{u\, (2\pi)^{1/2}\, \sigma_y\, (2\pi)^{1/2}\, \sigma_z} \qquad (3)$$

where

$$g_1 = \exp\,(-0.5\, y^2/\sigma_y^2) \qquad (4)$$

$$g_2 = \exp(-0.5\ (Z-H)^2/\sigma_z^2) + \exp(-0.5\ (Z+H)^2/\sigma_z^2) \qquad (5)$$

$$g_3 = \sum_{N=-\infty}^{\infty} (\exp(-0.5(Z-H+2NL)^2/\sigma_z^2 + \exp(-0.5(Z+H+2NL)^2/\sigma_z^2) \qquad (6)$$

c : concentration in $\mu g/m^3$

Q : emission rate in $\mu g/s$

u : wind speed in m/s

σ_y : standard deviation of horizontal distribution of plume concentration at the downwind distance 'x' for the appropriate stability in 'm'

σ_z : standard deviation of vertical distribution of plume concentration at the downwind distance 'x' for the appropriate stability in 'm'

g_3 : converges quite fast, so it is sufficient take the value of N ranging from 5 to +5.

Atmospheric stability is determined from "broad meteorological parameters" using the method of Pasquill and Gifford from wind speed and isolation data. Dispersion stability classes are calculated from the Pasquill-Gifford curves.

Equations 1-3 are used to estimate the short term (1-hourly) concentration of c_1 of pollutants. In order to calculate 8-hourly concentrations c_8, a power law function of time ratio is used:

$$c_8 - c_1\ (t_1/t_8)^{\alpha} \qquad (7)$$

A suggested value of α is 0.4. Such a relationship is valid in the range of 3 minutes to 24 hours.

The concentration of pollutants under episodal conditions can be calculated using Equations 2 and 3. Such worst case scenarios can occur due to the availability of only a limited mixing layer in the vertical direction for the pollutants when the short term ground level concentrations become abnormally high. The plume could be trapped between the ground and a stable layer aloft, a phenomena known as trapping. A surface based inversion that develops at night is eliminated slowly as the ground gets warmed by the morning sun, a condition known as fumigation when the short term concentration during the mid-morning can become quite high, especially in the winter months.

Long term averages (monthly, seasonal or annual) are calculated using the following equation in TERIMAQ:

$$c = \frac{(2/\pi)^{1/2}Q}{100(2\pi x/\Theta)} \sum_{N} \sum_{X} \frac{f(\Theta,S,N)}{u_N \, \sigma_{zs}} \exp(-1/2(H/\sigma_{zs})) \qquad (8)$$

c : long term concentration at a distance x along the direction Θ in $\mu g/m^3$

Q : emission rate in $\mu g/s$

S : represents number of stability classes

N : represents the number of wind speed classes

$f(\Theta,S,N)$:is the stability wind rose, the percentage frequency of the time for which wind blows from direction Θ for the stability condition S and in the wind speed class N

u_N: mid value of the wind speed class N

σ_{zs}: vertical dispersion parameter corresponding to stability condition S

H : effective stack height

95%tile concentration at varying distances from the source is also calculated. Concentration is evaluated for each wind direction and wind velocity class; each of them occurs with a frequency specified by the wind rose for the averaging period. There are a hundred such values. These are arranged in descending order and the 96th value from the top is the 95%tile concentration. These are often significant indices of air quality because standards are sometimes specified as the number of times in a year the concentration can exceed a prescribed value.

In practice, stability wind rose diagrams are often not available. The distribution of stability is estimated from the "broad meteorological parameters". The wind rose $f(\Theta,N)$ is assumed to be the same for all stability classes. The long term concentration is calculated using the wind rose $f(\Theta,N)$ for each stability class and weighting them according to the distribution of the stability classes to estimate the average.

Brigg's plume rise equations are used to calculate the effective stack height H (i.e. height of emission after the plume has risen over the physical stack height) in TERIMAQ.

Assumption of a gaussian distribution of the time averaged pollutant concentration in the vertical and horizontal direction used in TERJMAQ provides a practical and relatively simple method for modelling air pollution.

However, the model has several limitations which are summarised below:

- The assumption of steady state conditions in the model implies that the applications of the model should be limited to 20-30 km downwind of the source.
- While the model is useful for estimating the maximum ground level concentration (GLC) in a regulatory context, it is not particularly accurate for predicting concentration at specific locations during specific times.
- Concentration values obtained are generally correct within a factory of 2, but the model has a tendency to underestimate, rather than overestimate, measured short term concentration.
- The wind speed used in the model ought to be the mean through the vertical extent of the plume but since only the surface wind speed is available, this is scaled up to the effective stack height.
- The tracer experiment results, on which the Pasquil Gifford dispersion coefficients are based, involved releases near the ground in a rural terrain with measurement period of 3-10 minutes. Thus the application of these parameters to elevated point sources for a 1-hour averaging period is an extrapolation of the dispersion values without much technical basis.
- The choice of discrete stability classes does not model the atmospheric turbulence which is continuous and not a stepwise phenomenon very well.